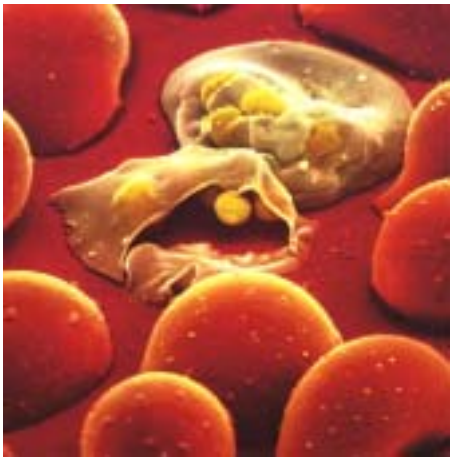
Report

Project 286

Malaria prevention and treatment, Busukuma, Uganda



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Executive Summary

About 60% of the population of Busukuma*, a village in Uganda, suffers from malaria. The problem of the large occurrence of malaria in this village influences people's health, economical and social status and is a cause of many deaths. The community of Busukuma has been seeking support to reduce the level of malaria incidences in their village. In dialogue with the Global Neighbour Network NABUUR*, and later on with the project team of Wageningen University, a project was defined to develop an action plan for malaria prevention and treatment to reduce the malaria incidence in Busukuma.

To be able to decide on specific prevention and treatment methods best suitable for Busukuma, a problem analysis of the disease malaria and its full impact on the quality of life is necessary. For this analysis the Precede/Proceed-model*, in which several steps are distinguished to cover all aspects of a specific health problem of Green and Kreuter (2005) was used (appendix 1). The analysis starts with the disease malaria in general, describing its lifecycle, transmission, symptoms and its most important prevention and treatment methods. These methods include the use of Insecticide Treated Nets (ITNs), Intermittent Preventive Treatment (IPT), Indoor Residual Spraying (IRS), Environmental Management (EM), other prevention methods at household level, Home Based Management (HBM), Artemisinin-based Combination Therapy (ACT) and other treatment methods at household level. For all these methods a cost-effectiveness analysis was conducted, to indicate which method could be economically most suitable for malaria control in Busukuma.

Not only the cost-effectiveness of the methods is important to take into account on deciding on suitable intervention methods, but equally important is to take a look at action for malaria control already present in the country. This continuing action is done by the government of Uganda and Non-Governmental Organisations (NGOs) and it is important that this action relates to the methods outlined in the action plan. Therefore, an investigation is done on the continuing action of these two groups.

Furthermore, to be able to make an accurate decision on malaria intervention methods suitable for Busukuma, it is extremely important to be informed on the local situation in the village. This information has been obtained through the local representative of the village. Understanding was generated on environmental and

behavioural conditions that may influence the malaria problem. These conditions are influenced by many factors, such as knowledge, beliefs and myths, which can negatively influence the implementation of the methods. Therefore, the changeability of these factors has been determined so that a decision could be made on suitable and effective intervention methods for Busukuma.

In the decision making phase, each intervention method has been reviewed concerning their cost-effectiveness, the continuing action, influencing factors and their changeability, and if they fit in the local situation of Busukuma. On the basis of these factors the following prevention and treatment methods have been chosen to be implemented: the use of ITNs, the use of small-scale prevention methods at household level and the promotion of anti-malarials as prevention and treatment drug (including IPT) to change the health seeking behaviour of the villagers.

For the successful implementation of these intervention methods in the village, recommendations have been made. First of all it is recommended that the overall coordination should be done by NABUUR. This includes the set up of fundraising activities and the search for partnership with local NGOs or volunteers working on the implementation of malaria programs at local level. For each intervention method, recommendations are given how to further build the knowledge and change the current behaviour for effective malaria prevention and treatment. It is also important to be able to complement the knowledge that already exists in the village on malaria control. For a successful implementation, it is important that the villagers are actively involved in the project. This involvement will be created by the active participation in a discussion group and going into dialogue with the villagers. These recommendations are the basis of the action plan, in which the recommendations are translated into concrete steps.

Abbreviations

ACT - *Artemisinin-based Combination Therapy*
AFM - *Africa Fighting Malaria*
AIDS - *Acquired Immuno-Deficiency Syndrome*
AMREF - *African Medical and Research Foundation*
ARDS - *Acute Respiratory Distress Syndrome*
ASAP – *As Soon As Possible*
CBO - *Community Based Organisation*
CDC- *Centre of Disease Control*
DALY - *Disability-Adjusted Life Year*
DDT - *Dichloro-Diphenyl-Trichloroethane*
EHP – *Environmental Health Project*
EM - *Environmental Management*
GDP - *Gross Domestic Product*
HBM - *Home Based Management*
HIV – *Human Immunodeficiency Virus*
IPT - *Intermittent Preventive Treatment*
IRS - *Indoor Residual Spraying*
ITN - *Insecticide Treated Net*
LLITN - *Long Lasting Insecticide Treated Net*
MCSP - *Malaria Control Strategic Plan*
MCP - *Malaria Control Programme*
MOH - *Ministry Of Health*
NGO – *Non-Governmental Organisation*
NK - *Natural Killer*
RBM - *Roll Back Malaria*
RTI - *Research Triangle International*
SP - *Sulfadoxine-Pyrimethamine*
TNF – *Tumour Necrosis Factor*
UBOS – *Uganda Bureau Of Statistics*
UNICEF - *United Nations International Children's Emergency Fund*
USAID - *United States Agency for International Development*
WHO - *World Health Organisation*

Terms

Anaemia - *Deficiency of red blood cells and/or hemoglobin*

Anopheles **-** *Mosquito species that is able to transmit malaria*

Antenatal clinic – *Clinic for pregnant women*

Antibody - *Large Y-shaped protein used by the immune system to identify and neutralize foreign objects like bacteria and viruses*

Antropophilic – *In favour of humans*

Busukuma **-** *Rural village in Uganda*

Cytokines - *A group of proteins and peptides that are used in organisms as signaling compounds*

Duffy receptor – *Receptor on red blood cells, if missing, P. vivax can not infect a human host*

Dyscrasias - *An abnormal or physiologically unbalanced state of the body*

Endemic - *An infection is said to be endemic in a population when that infection is maintained in the population without the need for external inputs*

Erythrocytes- *Red blood cells*

Extrinsic cycle – *Growth cycle of a parasite*

Filter-feed – *Feeding by straining suspended matter and food particles from water, typically by passing the water over a specialized structure, such as the baleen of baleen whales*

Gametocyte - *A cell capable of dividing to produce gametes, e.g., a spermatocyte or oocyte (sexual stage parasites)*

G6PD deficiency - *An inherited condition in which the body does not have enough of the enzyme glucose-6-phosphate dehydrogenase, which helps red blood cells function normally*

Haemoglobin – *The iron-containing oxygen-transport metalloprotein in the red blood cells of the blood in vertebrates and other animals*

Haemoglobin C - *An abnormal hemoglobin with substitution of a lysine residue for glutamic acid residue at the 6th position of the ß-globin chain. This mutated form reduces the normal plasticity of host erythrocytes*

Haemolysis - *Destruction of the red blood cells*

Instar - *A developmental stage of arthropods, such as insects, between each moult (ecdysis), until sexual maturity is reached*

Interferon-gamma - *Natural protein produced by the cells of the immune system of most vertebrates in response to challenges by foreign agents such as viruses, bacteria, parasites and tumor cells*

Intra-uterine growth retardation - *Condition where an embryo in the uterus does not reach one of the growth stages at the expected age*

In vitro - *Refers to the technique of performing a given experiment in a test tube, or, generally, in a controlled environment outside a living organism*

Jaundice - *Yellowing of the skin, conjunctiva (whites of the eyes) and mucous membranes caused by increased levels of bilirubin in the body*

Lactic acid - *Also known as milk acid, is a chemical compound that plays a role in several biochemical processes*

Leukocytes - W*hite blood cells*

Lymphocyte - *Type of white blood cell in the vertebrate immune system*

Macrophage – *A phagocyte, acting in both nonspecific defense (or innate immunity and in specific defense (or cell-mediated immunity) of vertebrate animals*

Malaria-poverty trap – *A trap in which malaria leads to higher costs, which leads to more poverty, which leads to higher incidence of malaria, and so forth*

Malarial splenomegaly - *An enlargement of the spleen due to the disease malaria*

Merozoite - *One of the organisms formed by multiple fission of a sporozoite within the body of the host*

Microflora – *The gut flora or micro organisms that normally live in the digestive tract and can perform a number of useful functions for their hosts*

Monocyte - *Part of the human body's immune system that protects against blood-borne pathogens and moves quickly to sites of infection in the tissues*

NABUUR - *Global neighbour network that gives communities in developing countries access to their global Neighbours via the Internet*

Natural Killer cell – *Form of cytotoxic lymphocyte which constitutes a major component of the innate immune system*

Neutrophil – *A type of white blood cell that forms an integral part of the immune system*

Oviposit - *To lay eggs, used especially for insects*

Paralysis – *The complete loss of muscle function for one or more muscle groups*

Parasitemia - *The quantitative content of parasites in the blood. It is used as a measurement of parasite load in the organism and an indication of the degree of an active parasitic infection*

Peak transmission season – *Season when incidence of malaria is highest (during rain season from July to October)*

Plasmodium **-** *Malaria parasite*

Precede/Proceed-model **-** *Framework for the process of systematic development and evaluation of health education programs*

Prophylactic - *Refers to any medical or public health procedure whose purpose is to prevent, rather than treat or cure, disease*

Pupa - *The life stage of some insects undergoing transformation*

Splenectomy – *Surgical removal of the spleen*

Sub-Saharan Africa - *Part of Africa below the Sahara*

Tertian – *Every third day fever*

Thalassemias - *A recessive trait inherited disease of the red blood cells*

Therapeutic - *Having or exhibiting healing powers*

Transmission - *The act of passing something on*

Vector propagation – *Expansion of any device of transportation or movement*

Quartan – *Every fourth day fever*

Content

Introduction

About 60% of the population of Busukuma*, a village in Uganda, suffers from malaria. Uganda is a country in Sub-Saharan* or East Africa consisting of many districts. Each district is divided into sub-districts, counties, sub-counties, parishes and villages. The village Busukuma is situated in the sub-county Busukuma, part of the Wakiso district. The problem of the large occurrence of malaria in this village influences people's health, economical and social status and is a cause of many deaths. The community of Busukuma has been seeking support to reduce the level of malaria incidences in their village. In dialogue with the Global Neighbour Network NABUUR*, and later on with the project team of Wageningen University, a project was defined to develop an action plan for malaria prevention and treatment to reduce the malaria incidence in Busukuma.

To be able to develop an adequate action plan, an analysis has to be done concerning the problem situation. For this analysis the Precede/Proceed-model* of Green and Kreuter (2005) is used, outlined in Appendix 1. First of all, the analysis includes an overview of the disease malaria in general with its most common prevention and treatment methods, including a cost-effectiveness analysis of these methods. Secondly, the impact malaria has on the quality of life in Uganda is discussed. Thirdly, it is reviewed what the continuing action against malaria is by the government and other organisations. The analysis continues with the village Busukuma in general and the environmental and behavioural conditions influencing the occurrence of malaria in the community. Also an investigation is done on the factors influencing the environmental and behavioural conditions in Busukuma, such as knowledge, traditions and beliefs. Finally, factors influencing specific intervention methods are discussed. In the decision making phase, each intervention method will be reviewed concerning their cost-effectiveness, the continuing action, influencing factors and their changeability, and fit to the local situation of Busukuma. Conclusions and recommendations can then be given, forming the basis of the action plan.

The action plan consists of a description of the 1) desired situation, 2) target group, 3) activities/ channels, 4) messages and 5) logistics concerning the actions to be taken. These actions are to be derived from the results from the conclusions and recommendations given.

According to the above mentioned statements the following objectives will have to be reached at the end of this project:

1) Analyzing the problem situation of the widespread disease malaria in Busukuma.
2) Reviewing the results from the problem analysis and discussing solutions for malaria prevention and treatment to fit the local situation (decision making and recommendations).
3) Making the end product: an action plan for malaria prevention and treatment in Busukuma.

1. The disease malaria

In this chapter the disease malaria is discussed, including its lifecycle, transmission* and symptoms. The multiple effects of malaria occurrence on the country Uganda are described. Furthermore, the most important and most common prevention and treatment methods will be investigated, ending with a cost-effectiveness analysis of these methods. The objective of this chapter is to create an overview of the disease malaria and how to combat it most efficiently.

1.1 Malaria in general

Malaria is the most serious parasitic disease in the world, which occurs in tropical regions. Each year 300-500 million people are infected and over a million people die as result of this infection (Snow et al., 2005). Most of the malaria cases (about 90%) occur in Sub-Saharan Africa. Children under the age of five and pregnant women are most vulnerable for the disease. In these groups most of the fatal malaria cases occur (WHO, 2005a; CDC, 2007).

1.2 Malaria in Uganda

Malaria is endemic* in 95% of Uganda. The remaining 5% are epidemic-prone areas in the highlands of the South, West and East. Therefore, malaria is a very serious health problem and currently poses the most significant threat to the population's quality of life. It is responsible for up to 40% of outpatient visits (a patient who is admitted to a hospital or clinic for treatment that does not require an overnight stay), 25% of hospital admissions and 14% of hospital deaths. There is a case-fatality rate of 3-5%, which is probably an underestimate (MCSP, 2001).

The number of reported cases of malaria led to more than 12 million in 2003 when the total population number was nearing 29 million. In Wakiso district specifically, the reported malaria cases were over 300,000 (WHO/UNICEF, 2005).

1.3 Lifecycle of malaria

Female mosquitoes that bite an infected human and subsequently an uninfected human spread malaria, thus acting as vector. A mosquito is attracted to a potential blood donor by emitted odours, especially sweat odour. The odours that

a human emanates are influenced by gender, age, sex and diet, but also other physical and chemical characteristics like body colour, body moisture, body temperature and body mass (Takken, 1991; Takken, 1999).

When a female *Anopheles** bites an infected human, the parasites that she picks up will spread and develop in the mosquito's body. To transmit malaria successfully, the mosquito must survive long enough after she has been infected to allow the parasites she now harbours to complete their growth cycle (extrinsic cycle*). That cycle takes 9-21 days at 25°C. Warmer ambient temperatures shorten the duration of the extrinsic cycle, thus increasing the chances of transmission (CDC, 2007). Conversely, below a minimum ambient temperature, the extrinsic cycle cannot be completed and malaria cannot be transmitted.

When a mosquito bites a human, she injects a bit of her saliva (a watery and somewhat frothy substance produced in the mouth). This saliva contains products that prevent the blood from clotting and may also contain the malaria parasites. Mosquitoes can thus transmit the parasite through their saliva from one person to another. In a then infected human the parasites grow and multiply in the liver cells and then in the red blood cells (Figure 1). Successive broods of parasites grow inside the red blood cells and destroy them, releasing daughter parasites (merozoites*) that continue the cycle by invading other red blood cells.

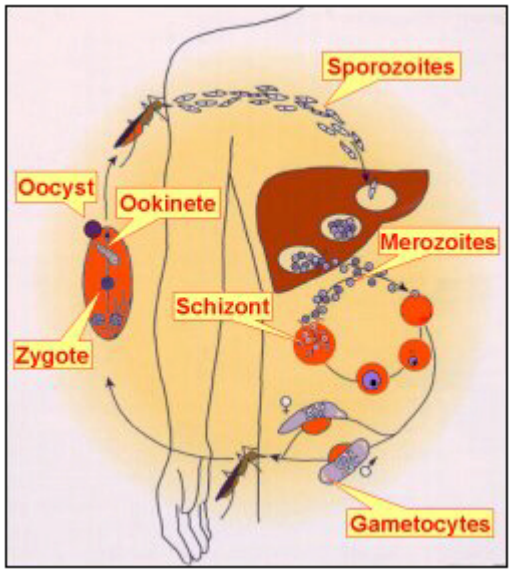

Figure 1. The lifecycle of malaria. Source: Leiden University Medical Centre.

These blood stage parasites (gametocytes*) cause the symptoms of malaria and are the ones picked up by a mosquito when she drinks a blood meal from an infected person. This starts another extrinsic cycle of growth and multiplication in the mosquito (CDC, 2007). More information about the biology of the parasite and of the mosquito can be found in Appendix 2 and 3, respectively.

1.4 Malaria parasites and vectors in Uganda

In Uganda three mosquito species are responsible for malaria transmission, namely *Anopheles gambiae s.s.*, *Anopheles arabiensis* (part of the *Anopheles gambiae s.l.*) and *Anopheles funestus*, all different in host preference and host seeking behaviour (Ministry of Health, 2007).

When they bite a human that suffers from malaria, the mosquitoes of this family can pick up a one-celled organism called *Plasmodium**. Subsequently the mosquito transmits these one-celled organisms to another human during the next blood meal. Four different species of *Plasmodium* cause symptoms of malaria in humans. These species include *Plasmodium vivax, Plasmodium falciparum, Plasmodium malariae* and *Plasmodium ovale.* Most of the cases (95%) of malaria in Uganda are a result of an infection with *Plasmodium falciparum*.

An. gambiae s.s. is the main malaria vector in Sub-Saharan countries and is a very efficient *Plasmodium* transmitter. This is due to its longevity, its preference to rest and bite inside houses, its preference for human blood and its susceptibility for the parasite. The behaviour of this species is specialized upon its human hosts and therefore only bites during the last four hours of the night (Lehane, 2005).

The *An. arabiensis* thrives well in dry environments and is opportunistic, which means that it bites more hosts. In East Africa the females of this species appear to show a preference for feeding on cattle, sheep, goats and donkeys. However, due to the high number of mosquitoes present, this species might play a role in malaria transmission (Mendis et al., 2000).

An. funestus females are highly antropophilic* and also like to bite inside houses resulting in the great bulk of blood feeding taking place indoors after 22.00 up to dawn. This behaviour makes this species an important vector for malaria parasites, although this mosquito is less susceptible for *Plasmodium s.s.* compared to *An. gambiae s.s.* (Mendis et al., 2000).

1.5 Symptoms of malaria

The disease malaria has different symptoms, which may be mild, to life threatening. Following the infective bite by the *Anopheles* mosquito, an incubation period goes by before the first symptoms appear. In most cases this

period varies from 7 to 30 days. The shorter periods are most frequently observed with *P. falciparum* and the longer periods with *P. malariae*.

Symptoms of malaria are (CDC, 2007):

- Fever attacks every second or third day
- Chills
- Sweats
- Headaches
- Nausea and vomiting
- Body aches
- General malaise

Physical findings may include:

- Elevated temperature
- Perspiration
- Weakness
- Enlarged spleen

In *P. falciparum* malaria additional findings may include:

- Mild jaundice*
- Enlargement of the liver
- Increased respiratory rate

Severe malaria occurs when *P. falciparum* infections are complicated by serious organ failures or abnormalities in the patient's blood or metabolism. The manifestations of severe malaria include (CDC, 2007):

- Cerebral malaria, with abnormal behaviour, impairment of consciousness, seizures, coma, or other neurological abnormalities
- Severe anaemia* due to haemolysis*: destruction of the red blood cells occurring especially in young children with frequent infections that are inadequately treated
- Haemoglobinuria: haemoglobin* in the urine due to haemolysis
- Acute Respiratory Distress Syndrome (ARDS) due to fluid build up in the lungs
- Abnormalities in blood coagulation and thrombocytopenia (decrease in blood platelets)
- Cardiovascular collapse and shock
- Acute kidney failure

- Hyperparasitemia: more than 5% of the red blood cells are infected by malaria parasites
- Metabolic acidosis: excessive acidity in the blood and tissue fluids
- Hypoglycemia: low blood glucose which may also occur in pregnant women with uncomplicated malaria, or after treatment with Quinine

Severe malaria most often occurs in people who have no or a decreased immunity to malaria. This includes all residents of areas with low or no malaria transmission, and young children and pregnant women in areas with high transmission. In all areas, severe malaria is a medical emergency and should be treated urgently and effectively. More information on the disease malaria can be found in Appendix 4.

1.6 Immunity

Both young children and pregnant women are most at risk of getting malaria. This is because young children have no acquired immunity under the age of three and women have a lowered immune response during pregnancy. People residing in malaria-endemic regions acquire immunity to malaria through natural exposure to malaria parasites. This naturally acquired malarial immunity is protective against parasites and clinical disease and results only after continued exposure from multiple infections with malaria parasites over time. This immunity limits high-density parasitemia*; however it does not lead to sterile protection (CDC, 2007)

Malaria parasites infect different targets, such as liver and red blood cells. Therefore different immune responses are elicited by infection. Experimental studies (CDC, 2007) have shown that antibodies, such as lymphocytes*, monocytes*, macrophages*, Natural Killer* (NK) cells, and neutrophils*, can mediate protection in malaria and/or developing severe symptoms. The mechanism of the protective effect of the immune system and genetic factors that influence malaria are explained in Appendix 5.

1.7 Resistance

Malaria mosquitoes have developed resistance against several insecticides commonly used in agricultural setups and vector control programs, making the control of the vector more difficult. Resistance is reported in *An. gambiae* and *An. funestus* to pyrethroids, an insecticide also used in the impregnation of bed nets

(CDC, 2007). Resistance against other insecticides is detected but not reported as widespread.

Furthermore, malaria parasites have developed resistance against different anti-malarials, such as Chloroquine, Amodiaquine and Sulfadoxine-Pyrimethamine (SP), due to intensive use (CDC, 2007). This phenomenon has led to a decline in the number of effective anti-malarials and treatment methods. Nowadays, there are also medicines used in East Africa which do not yet induce resistance, including Quinine, Mefloquine and Artemisinin. To prevent the development of resistance, it is important to map resistance and use a combination of medicines. More detailed information on resistance of mosquitoes to insecticides and anti-malarials can be found in Appendix 6.

1.8 Important prevention methods

Vector control measures are important to prevent people from being bitten by mosquitoes that carry the malaria parasite *P. falciparum*. These vector control measures in epidemics must be supported by personnel, supplies and equipment, preparedness planning, and supervision and evaluation. The most important and most frequently used vector control measures in Uganda will be discussed here.

Possession and use of Insecticide Treated Nets (ITNs). Most malaria carrying mosquitoes bite at night. Mosquito nets, if properly used and maintained, can provide a physical barrier to mosquitoes. If treated with insecticide, the effectiveness of nets is greatly improved, generating a chemical halo that extends beyond the mosquito net itself. This tends to repel mosquitoes from biting or shorten the mosquito's life span so that she cannot transmit malaria infection. The insecticides used for net treatment are relatively non-toxic to humans, mammals and birds (WHO, 2007a). Long-lasting insecticide treated nets (LLITNs) are nets treated with chemicals that ensure protection for four to five years. This makes regular re-treatment unnecessary (RBM, 2007c). Pregnant women protected by ITNs every night produce 25% fewer underweight or premature babies (RBM, 2007e). Furthermore, ITNs result in improvement in maternal health, infant health and survival (RBM, 2007e).

Use of Intermittent Preventive Treatment (IPT) for pregnant women. IPT involves providing all pregnant women with at least two preventive treatment doses of an effective anti-malarial during routine antenatal clinic* visits, one in the second trimester and one in the third. This approach has been shown to be safe,

inexpensive and effective. The treatment helps to protect pregnant women against maternal anaemia and low birth weight. For example, a study in Malawi evaluating IPT, showed a decline in placental infection (32% to 23%) and a decline in the number of low birth weight babies (23% to 10%). This study also found that 75% of all pregnant women took advantage of IPT when offered (Utzinger et al., 2001).

Indoor Residual Spraying (IRS). IRS involves spraying persistent insecticide onto the inside walls and ceilings or onto the underside of the roofs of houses. This kills mosquitoes when they are resting indoors after having had a blood meal. Thus, IRS in general kills the mosquito after and not before the infectious bite. Therefore, IRS does not directly prevent people from getting malaria. However, it does reduce the number of present vectors and transmission of the malaria parasite. To be effective, timing is critical, which means that spraying has to be done before the expected peak transmission season*. Additionally IRS requires coverage of at least 85% of the walls, ceilings etc., ensuring that the majority of mosquitoes are exposed to the insecticide. Although many opponents do not accept the use of Dichloro-Diphenyl-Trichloroethane (DDT) for IRS, it has been shown that DDT is more effective and less expensive than many other insecticides in many situations (NetMark USAID, 2007).

Environmental management (EM). WHO defines EM for vector control as the planning, organisation, carrying out and monitoring of activities for the modification and/or manipulation of environmental factors or their interaction with man. The goal is to prevent or minimise vector propagation* and to reduce man-vector-pathogen contact. Important environmental interventions mainly based on minimising the breeding place for mosquitoes are (Utzinger et al., 2001; RBM, 2007d):

- Filling puddles
- Introducing fish which eat mosquito larvae
- Repairing and improving drainage which also improves the agricultural value of farm lands in one operation at a reasonable cost
- Pouring oils on stagnant ponds
- Vegetation clearance
- Modification of river boundaries
- House screening

Other prevention methods used at household level. Some of the above mentioned EM measures do not entail a significant cost and can be applied at household

level, such as the disposing of empty tins and containers to prevent accumulation of water, covering rainwater tanks, pouring oil on or draining of stagnant water, closing windows and doors early in the evening and closing holes and gaps in the walls/roof, etc. of the houses. Furthermore, burning mosquito coils, which expels mosquitoes, and eating a proper diet, which helps to make the body stronger and less susceptible to the disease, may also contribute to reducing malaria.

1.9 Important treatment methods

Appropriate treatment after infection with the malaria parasite may lead to a faster recovery and avoid death. The most important and most frequently used treatment methods in Uganda will be discussed here.

Home Based Management (HBM) of malaria. HBM entails educating community resource people (health workers, volunteers, mothers, drug vendors and shopkeepers) to recognize the symptoms suggestive of malaria and to deliver appropriate anti-malarial treatment. HBM aims to improve the self-medication practices in endemic countries. Treatment delays, such as distance to health centres, the child falling sick at night, costs involved in seeking care, and the mother unable to seek care costing money are likely to be dealt with by HBM (Nsungwa-Sabiiti et al., 2004).The four strategic components of HBM are:

- Ensuring access to effective anti-malarials (preferably pre-packaged) at community level
- Ensuring that community providers have the necessary skills and knowledge to manage malarial illness
- Ensuring a communication strategy to enable caregivers to recognize malaria illness early and take appropriate action
- Ensuring mechanisms for supervision and monitoring of community activities, including supply of anti-malarials

Artemisinin-based Combination Therapy (ACT). To counter the threat of resistance of *P. falciparum* to mono-therapies, combinations of anti-malarials based on Artemisinin compounds, especially Artesunate and Artemether, are now recommended by WHO for the treatment of *P. falciparum* malaria. These anti-malarials produce a very rapid therapeutic* response, a reduction of the parasite biomass and resolution of symptoms, are active against multi drug resistant *P. falciparum*, are well tolerated by the patients and have the potential to reduce transmission of malaria. If used alone, the Artemisinins will cure *P. falciparum* malaria in seven days, but studies have shown that in combination with certain

synthetic drugs they produce high cure rates in three days with higher adherence to treatment. RBM (2007b) currently recommends the following therapeutic options:

- Artemether-Lumenfantrine
- Artesunate plus Amodiaquine
- Artesunate plus Mefloquine
- Amodiaquine plus SP

Other treatment methods used at household level. Self-treatment is often applied after consulting family members with previous disease experience. This includes sponging with a wet cloth to cool the body temperature and administering traditional herbs or modern medicines that reduce diarrhoea, pain and temperature (Kengeya-Kayondo et al., 1994; Nsungwa-Sabiiti et al., 2004). Sometimes help is sought from traditional healers when the symptoms persist (Nsungwa-Sabiiti et al., 2004). Simultaneous treatment with both traditional and modern medicines is sometimes practiced, putting the patient at risk of overdose and counteracting or neutralising the effect of the medicines. Furthermore, anti-malarials are often given to children irrespective of the cause of the fever (Rosalind et al., 1997). Self-treatment and traditional healing may lead to a delayed cure, increase in the spread and occurrence of malaria complications, including the development of drug resistance (Nuwaha, 2002) as compared to seeking help from the formal health sector, which is usually the final resource.

1.10 Cost-effectiveness analysis

For expansion of effective malaria prevention and treatment methods, information is needed on the costs and effectiveness of certain methods. Even though the existing knowledge on cost-effectiveness is scarce, an attempt to an overview is given below.

Goodman et al. (1999) estimated cost-effectiveness ratios for some of the prevention methods in Sub-Saharan Africa, namely ITNs, IPT and IRS. Costs were expressed in 1995 US$ using the purchasing power of the dollar, derived from the US consumer price index (US Census Bureau, 1999). Effectiveness was calculated in terms of Disability-Adjusted Life Years (DALYs) averted, a measure of health outcome incorporating premature death and morbidity or disability. The DALYs were combined with costs to produce a likely range for the cost per DALY averted of each intervention used in a very-low-income country.

For insecticide treatment of existing nets, the cost-effectiveness range was US$4-10 per DALY averted. For provision of nets and insecticide treatment the range was US$19-85. The range for IRS was US$32-58 (two rounds of spraying per year). For IPT the range is between US$4 and US$29 (Figure 2).

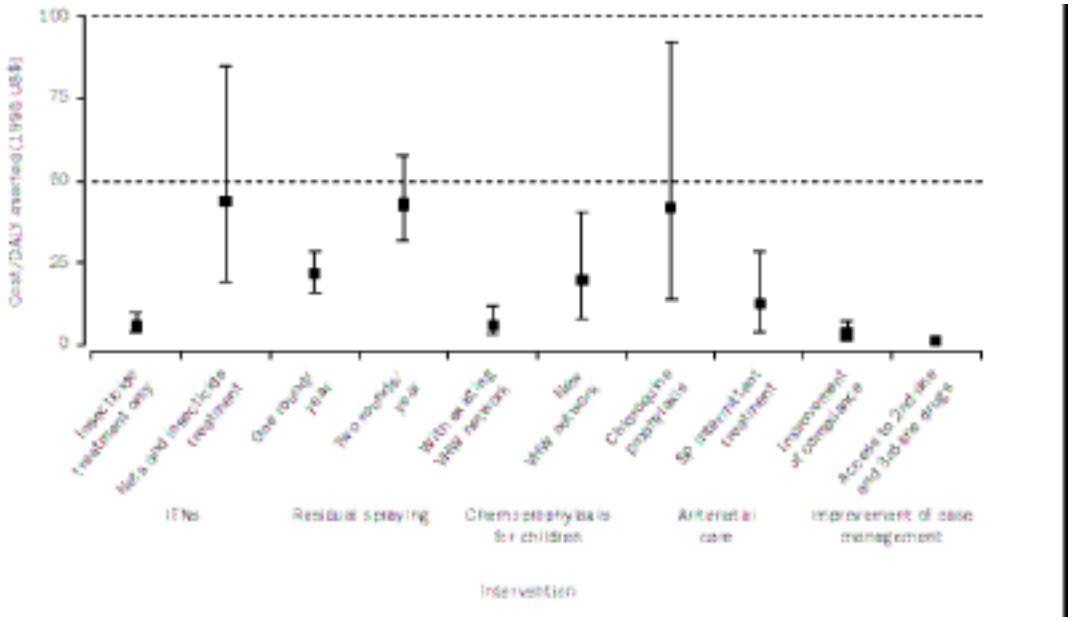

Figure 2. Cost-effectiveness ranges and means in a very-low-income country with high malaria transmission. VHW = Village Health Worker; SP = Sulfadoxine-Pyrimethamine; ITN = Insecticide Treated Net, one treatment per year. Source: Goodman et al. (1999).

To review the cost-effectiveness of EM multiple malaria control programs were investigated (Utzinger et al., 2001). Especially a program launched in 1929 was useful for this purpose. The full package of the EM in this program consisted of vegetation clearance, modification of river boundaries, draining swamps, oil application to open water bodies and house screening. The costs per DALY averted were converted into 1995 US$. For EM the costs per DALY averted were relatively high during the first 3-5 years of program implementation: US$524-591. Costs per DALY averted decreased over the course of implementation: US$92 for the first three year maintenance and US$22 for the last three year maintenance.

For HBM, only little literature is available concerning the cost-effectiveness. According to Goodman et al. (not published yet), having access to affordable and appropriate treatment within 24 hours, will cost US$4 per appropriately treated case in the early implementation phase. For district-level implementation, the costs would be approximately US$0.84 for each appropriately treated case, varying between US$0.37 and US$1.36.

Although the costs of ACT are higher than non Artemisinin-based combination therapies, Morel et al. (2005) suggests that countries in Sub-Saharan Africa should switch to ACT use as quickly as possible since the resistance to non Artemisinin-based combinations is increasing rapidly. The cost-effectiveness for this method is approximately US$12 per DALY averted.

All data concerning cost-effectiveness for specific prevention and treatment methods are summarized in Table 1.

Table 1.Summary cost-effectiveness per malaria control method, in 1995 US$ per DALY averted. Source: derived from the literature from Goodman et al. (1999) and Utzinger et al. (2001).

Intervention methods	**Costs during first implementation**	**Costs during maintenance**
Insecticide Treated Nets	19-85	4-10
Intermittent Preventive Treatment	4-29	
Indoor Residual Spraying	32-58	
Environmental Management	524-591	22-92
Home Based Management	4*	0.37-1.36*
Artemisinin-based Combination Therapy	12	

*Costs for HBM are in US$ per case treated

According to Goodman et al. (1999), all interventions would be an attractive use of resources if the cost-effectiveness range would be less than US$150 in each case. Thus, ITNs, IPT, IRS, HBM and ACT are attractive interventions for malaria control. The costs for EM are relatively high for the first three to five years of implementation (Utzinger et al., 2001), which makes this intervention less suitable for malaria control. However, small-scale EM interventions at household level, such as disposing of empty tins and closing windows and doors early, are relatively cheap and feasible.

Cost-effectiveness depends on various factors specific to each intervention, but certain common influences can be identified: length of the transmission season, the price of key commodities, behavioural factors, the degree of existing infrastructure and the degree of drug resistance. Because there is substantial regional variation in these factors, analyses should be adapted at a local level. To decide which methods are best applicable for Busukuma, it is assumed that these general cost-effectiveness findings can be applied.

2. Impact on quality of life

In this chapter the quality of life affected by the disease malaria will be discussed. The impact on the quality of life is multiple, since malaria doesn't only affect people's health, but also their economical and social status. It is important that an overview is given of the effect of malaria on these aspects of life to fully understand the impact of the disease.

2.1 Health impact

As mentioned before, malaria in Uganda leads to a lot of sickness and death each year. Certain groups are especially vulnerable to the disease, namely rural populations, poor people, children under five, pregnant women and people on the move.

Rural, often poor, populations carry an overwhelming burden of disease compared to urban centres, where a relatively better access to health services exists for early diagnosis and prompt and effective treatment (WHO, 2003b).

The two groups that bear the greatest burden of the disease are children under five years of age and pregnant women, especially the ones living in rural areas. These two groups have little or no immunity to malaria and are therefore more vulnerable than other groups. They suffer more attacks of malaria and are at greater risk of having the severe and complicated form of the disease. When they don't receive appropriate health care, they are more likely to die.

Malaria is Africa's leading cause of under-five mortality (20%) and constitutes 10% of the continent's overall disease burden. From the total of 12 million malaria cases in Uganda in 2003, the number of under-fives infected with malaria was over 3 million. Malaria specific death rate among the under-fives is 37/1,000 and 18/1,000 in high and low malaria endemic areas respectively, which translates to about 70,000-110,000 child deaths annually. With acute disease a child may die within 24 hours. Malaria kills children often in combination with other diseases and also causes childhood anaemia, reduced growth and mental retardation. Children have an average of six episodes of malaria each year.

Pregnant women are four times more likely to suffer from malaria attacks compared to non-pregnant women. In Sub-Saharan Africa, approximately 25 million pregnant women are at risk of *P. falciparum* infection every year (Ministry

of Health, 2007). In Uganda about 66% of pregnant women suffer from malaria (Nydomugyenyi et al., 1998). They are especially at greater risk in areas of high malaria transmission, due to their lowered immunity. Infection may include maternal anaemia and in severe cases, maternal death, still births, premature delivery, intra-uterine growth retardation*, and babies with low weights. Malaria in Uganda is responsible for nearly 60% of the miscarriages, contributing largely to infant mortality.

People on the move can transport infectious mosquitoes to malaria-free areas, which causes the reintroduction of the disease. Therefore, malaria is also a major killer of refugees and internally displaced people (Ministry of Health, 2007). The resettlement of refugees in camps makes these people vulnerable to malaria infection. In these camps inadequate water management and reduced or unavailable health facilities accumulate the incidence of the disease (Martens & Hall, 2002).

2.2 Economical impact

Malaria does not only cause health problems and death, it also constrains the economic development of the individual, the family, the community and the nation in several ways. Economists believe that malaria is responsible for a 'growth penalty' of up to 1.3% per year in some African countries, with a 32% reduction in the Gross Domestic Product (GDP) of countries in Africa where malaria is endemic, as in Uganda. The economic losses due to malaria in Africa have recently been estimated at about US$12 billion per year (WHO, 2003b). These economical losses have resulted in several coping strategies at household level to reduce them.

Malaria has shown to have significant direct and indirect costs. The direct costs of malaria include a combination of personal and public expenditures on both prevention and treatment of the disease. These costs may enhance poverty which in turn enhances malaria, since acquired malaria demands sufficient resources for treatment which are scarce for the poor. Thus, economic development is further decreased and people are locked in a malaria-poverty trap*.

Personal expenditures include individual or family spending on ITNs, aerosol sprays, mosquito coils, doctors' fees, anti-malarials, transport to health facilities, support for the patient and even funeral expenses (RBM, 2007a). A poor malaria-stricken family may spend up to 25% of its income on malaria prevention and

treatment. Furthermore, families are forced to hire labour to compensate for working days lost to morbidity (Ministry of Health, 2007). Public expenditures include costs made by government on maintaining health facilities and health care infrastructure, publicly managed vector control, education and research. It is estimated that 40% of health expenditures in Sub-Saharan Africa are spent on malaria treatment (Ministry of Health, 2007).

The indirect costs of malaria include loss of productivity and income associated with illness or death. In the case of illness this is expressed as the cost of lost workdays or absenteeism from formal employment and the value of unpaid work done in the home by both men and women (RBM, 2007a). In the Eastern part of Africa, where malaria epidemics mostly occur during seasons of peak agricultural activities, the disease not only excludes the sick ones from daily agricultural activities, but also the healthy ones who take care of their sick family members and relatives. It is estimated that workers suffering from a malaria bout can be incapacitated for 5-20 days. The lack of enough manpower during peak agricultural activities decreases productivity and hence lowers income and aggravates food insecurity (WHO, 2003b).

Since malaria is accountable for a great number of man-hours lost, industries and agricultural enterprises, like tea, sugarcane, coffee, rice and tobacco estates, are affected in their production and revenue. It is known that investors are not much interested in investing in countries where malaria is wide spread. It is a fact that in those countries, profits will be eroded through absenteeism from work and on treatment of malaria infected workforce. Thus, there is a loss in investment funds, which in turn affects the economy of Uganda.

Coping strategies can be defined as a set of actions that aim to manage the costs of an event that threatens the welfare of some or all of the household members (Sauerborn et al., 1996). The strategies to cope with direct and indirect costs of illness include using savings, borrowing from social networks, selling food stores, reducing consumption of (first) non-essentials and later the more essential items, diversifying income sources, reducing investments by withdrawing a child from school and selling assets such as land and/or machinery. The possibility of households to cope with these costs depends on (Russell, 2003):

- Their access to strategies
- The affordability and sustainability of the strategies
- The vulnerability or resilience of the household resources
- The severity and duration of the illness

2.3 Social impact

Malaria has a greater impact on Africa's human resources than simply lost earnings. It also has a huge social impact by influencing fertility, gender inequality and the development of children. This impact has resulted in coping mechanisms at household level which help families and individuals through periods of sickness due to malaria.

Historical evidence has shown that high infant and child mortality rates are linked closely to high fertility rates (Sachs & Malaney, 2002). The reason for this is that parents have additional children to replace the ones they lose and therefore base their fertility decisions on the desire for a certain number of surviving children. A high fertility rate among poor households is likely to lead to reduced investments in education per child, especially in the education of girls. This decision is based on the knowledge that these girls, when older, spend most of their time rearing children. This limits their employment choices and working time in the labour force creating little economical returns to education for girls and resulting in gender inequality.

Malaria hampers children's schooling and social development through both absenteeism, and permanent neurological and other damage associated with severe episodes of the disease (RBM, 2007d). It is estimated that in endemic areas malaria may impair as much as 60% of the schoolchildren’s learning ability. For example, malarial children are found to have a poorer nutritional status than non-malarial children, which in turn can impair brain development. Furthermore, malarial children perform worse on fine motor functions. There can also be long-term cognitive effects of severe cases of malaria, including behavioural disorders and impairment in the ability to carry out functions such as initiating, planning and executing tasks (Sachs & Malaney, 2002).

The most basic and strongest coping mechanism is looking for support within the family (Cuny, 1983). However, frequent illness or deaths of children due to malaria can also lead to misunderstandings within and between families. Those with sick or dying children are often likely to accuse parents of healthy children of bewitching their children. This will lead to hatred within and between families (Ministry of Health, 2007).

Religion can also help people to cope in various ways by the faith that often accompanies it. It affords the individual a sense of self-esteem and mastery in the face of a disease (Prado, 2004). Religious involvement may often be invoked

in situations where stress either accompanies or exacerbates a life-threatening health condition such as malaria. However, religion might also cause apathy among believers, since they put their fate in the hands of God, which can be seen as a sort of fatalism.

Finally, it often seems that malaria has become part of life of people in highly endemic regions. People have the belief that malaria control is unachievable because mosquitoes are so abundant in their community. They haven't yet experienced effective prevention and treatment methods. Thus, over the years they have, to a certain extend, accepted malaria as a normal aspect of life.

3. Continuing action against malaria

The government of Uganda and several organisations are active in the fight against malaria. It is important that an overview is given of these actions and the progress they have made in combating the disease. It should be possible to design the action plan, generated from this report, in accordance with the policy of this continuing action in the country.

3.1 Governmental action

The Government of Uganda, and more specifically the Ministry of Health (MOH), considers the fight against malaria to be of top priority. It has set up a Malaria Control Programme (MCP) including a Malaria Control Strategic Plan (MCSP) for the years 2001/2 to 2003/4, to prevent and control malaria and malaria related morbidity and mortality. The MCSP is based on objectives of Roll Back Malaria (RBM) set out in 1998 and on the targets of the Abuja Declaration generated by the African heads of state in April 2000. RBM is a global social movement aimed at controlling malaria to the level where it is no longer one of the major contributors to mortality and morbidity in the region by the year 2030. In April 2000, African Heads of State held a summit on RBM in Africa in Abuja, Nigeria, in which they set the following targets:

- To increase the proportion of the population who receive effective treatment for malaria within 24 hours of the onset of symptoms, from 30% to 60%
- To increase the proportion of pregnant women receiving protection against malaria through IPT to 60%
- To increase the proportion of under-fives, regularly sleeping under ITNs, from 5% to 50%
- To reduce malaria case fatality at hospital level from 5% to 3%

The MCSP stresses the importance of increased public knowledge and awareness of the signs and symptoms of malaria and prompt access to effective treatment. Under the plan, the Government approves four principal intervention strategies including vector control (ITNs and IRS), IPT, HBM, and epidemic prevention preparedness and response.

Successful implementation of these strategies and achievement of these targets will require a strong partnership between all stakeholders at all levels; this

includes families, communities, public and private sector service providers, and policy makers throughout the government, development partners, NGOs and the private sector. Generally, the plan will strengthen preventive and management capacity for malaria at all levels.

The implementation of the intervention strategies and the progress made since 2000 are outlined in Appendix 7.

3.2 Organisational action

To achieve the Abuja targets many organisations are occupied with the implementation of prevention and treatment projects:

- The WHO and UNICEF worked together on a malaria control project for Africa in 2005 and focused on the possession and use of ITNs, the use of IPT for pregnant women and the use of ACT (WHO/UNICEF, 2005).
- In 2004, several scientists initiated the Environmental Health Project (EHP) to fight malaria by using EM. The interventions that were put into action were: filling puddles, introducing larvae eating fish and repairing and improving drainage (Lindsay et al., 2004).
- The Ugandan Red Cross Society and partners have been fighting malaria for many years by focusing on the distribution of LLITNs (Uganda Red Cross Society, 2007).
- Africa Fighting Malaria (AFM) was formed in South Africa (2000) and in the United States (2003) and focuses on conducting research into the social and economic aspects of malaria. AFM is an advocate of IRS including the use of DDT (AFM, 2006).
- AMREF (African Medical and Research Foundation) was founded in 1957 as the Flying Doctors Service of East Africa and since that time has been working on anti-malaria programs, especially for the most in need. The foundation focuses on HBM, the provision of LLITNs, malaria control in pregnancy and behaviour and social change communication in support of all interventions (AMREF, 2006).
- The Research Triangle International (RTI) has been working since 2005 to apply anti-malaria intervention methods. The use of ITNs and the use of IRS were promoted and facilitated as much as possible (RTI, 2007).
- NetMark USAID (United States Agency for International Development) is investing time and money to reduce the burden of malaria by increasing the commercial supply of and the public demand for ITNs (NetMark USAID, 2007).

4. The village Busukuma

In chapters 1-3 general information, based on literature, is given on the disease malaria, prevention and treatment methods, the impact it has on the quality of life and the continuing action of the government and organisations. This chapter will first of all look at the environmental and behavioural conditions present in the village of Busukuma, allowing a full understanding of the local situation. The information on the village is partly obtained from the village representative through weekly questionnaires by e-mail, MSN and telephone contact. Unfortunately face to face contact to get in-depth information about the local situation was not possible, due to a lack of time and money. Additionally, in this chapter, a translation of the literature research (as outlined in the chapters above) will be made to the local situation.

4.1 Environmental conditions

Busukuma is a rural village situated in Uganda about 20 km from the capital city Kampala. Busukuma is settled close to Lake Victoria which also borders Kenya in the East and Tanzania in the South. Busukuma is part of sub-county Busukuma, lying in Kyandondo county, which in turn is part of the Wakiso district. The Wakiso district encircles Kampala and lies in the central region of Uganda, bordering Luwero district in the North, Mukono in the East, Kalangala in the South, Mpigi in the South-West and Mubende in the North-West (Figure 3). The district has markedly different areas of socio-economic development, ranging from sub-urban areas bordering the city to typical rural areas.

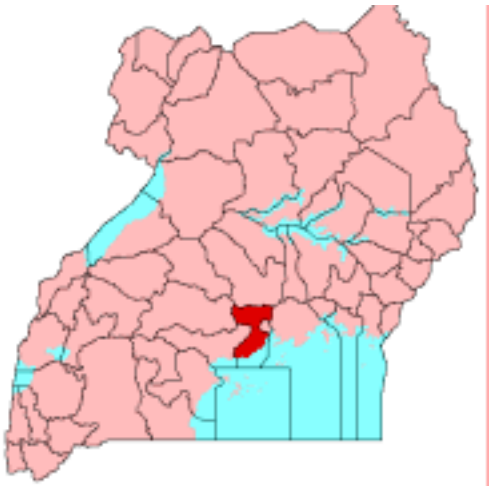

Figure 3. Uganda and its districts. Wakiso District is coloured red. Source: Wikipedia.

Environment. Wakiso district has a total area of 2,704 km^2 of which 1,710 km^2 is arable land and 994 km^2 is covered with forests, water and swamps. The area of Busukuma lies on high, flat land mainly used for farming activities. The village is partly swampy and partly covered with trees and heavy bushes. A very common type of tree in the village is the eucalyptus tree and bushes are mainly papyrus. Throughout the village a lot of puddles with stagnant water are present. These puddles are maximally filled during the rainy seasons or when lack of sunshine prevents evaporation. Therefore, many breeding places for mosquitoes are present in Busukuma.

Housing. The villagers of Busukuma have houses build of cow dung, bricks, iron sheets, grass and, when people have the finances, cement (Figure 4). According to the information from the village representative most houses don't have access to electricity, so they use fire or the brightness of the moon as a source of light. There are no wells with drinking water within the vicinity of three miles, so the majority of the villagers use puddles or try to collect rainwater in tanks near their houses. These tanks are open and can act as mosquito breeding sites with mosquito larvae often being detected in them.

Figure 4. Picture of a house in Busukuma village. Source: NABUUR.COM

Health facilities. There is one health centre in the sub-county Busukuma, situated in Kyapa, which can easily be reached by the villagers. In this centre ten people are employed. There are two nurses present on a daily bases; however, no doctor is available. In the health centre people can buy their anti-malarials if they have the financial possibility to do so. Under-fives suffering from malaria mainly receive the anti-malarials Chloroquine and Quinine and this is prescribed according to children's weight, where 5 kg of body weight equals 25 mg of Chloroquine and 50 mg Quinine. Pregnant women suffering from malaria receive SP and Chloroquine, depending on the persistence of their symptoms (nurses, personal communication). For operations villagers have to go to a hospital in Kampala.

A local shop is also present in Busukuma selling bed nets and anti-malarials for these prices in Ugandan Shilling (1 Euro = 2,357.84 Ugandan Shilling (UGX)):

- Bed nets: 15,000 UGX (6,36 euro)
- Insecticides: 12,000 UGX (5,09 euro)
- Chloroquine (100tabs): 35,000 UGX (14,84 euro)
- Quinine (100tabs): 13,000 UGX (5,51 euro)
- SP (100tabs): 45,000 UGX (19,09 euro)
- Malaquine (100tabs): 15,000 UGX (6,36 euro)

There is contact between the health centre and the local shop. Patients can get a prescription from the health centre to buy anti-malarials at the local shop. In this shop a person is employed who explains the prescriptions and the use of the medicines. If the symptoms persist, the person at the local shop sends the patients back to the health centre. All anti-malarials, at the health centre and the shop, are purchased from whole-sale pharmacies in Kampala.

Infrastructure. The central part of Wakiso district is traversed by the Trans-Africa and Entebbe-Kampala highways and is served by a network of secondary roads. Most roads in the village are poor, very small and only accessible by bicycle or foot. Main roads present are also of poor quality; they are sandy and full of dumps, but still accessible for cars (Kaaya, personal communication). The nearest paved road is Gayaza-Busika road leading to Kampala.

Climate. The majority of Uganda has a tropical climate that varies according to altitude. Busukuma, near Lake Victoria, lies in the Lake Victoria climate zone. This zone experiences two relatively dry seasons, one between December and March and another between June and July. Both periods are interrupted by thunderstorms so rainfall is fairly well distributed throughout the year. During the year the hottest months are from December to February with temperatures reaching approximately 29°C. The peak rainfall periods or “rainy seasons” are March to May and October to November with April being the wettest month.

Figure 5 shows the year’s average weather conditions covering rain, average maximum daily temperature and average minimum temperature for the capital city of Kampala. Since Busukuma lies only 20 km from Kampala, this figure is also assumed to be relevant for Busukuma. Due to these average weather conditions malaria is present all year round.

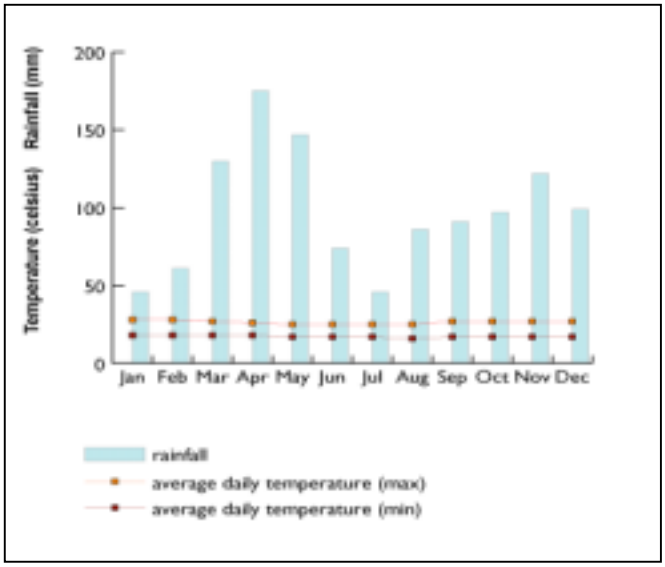

Figure 5. Average weather conditions. Source: BBC Weather.

4.2 Behavioural conditions

People. Wakiso district is the second most populated district in Uganda with a total population of 957,280 people (UBOS, 2002), with 241 households (approximately 2200 inhabitants) in the village Busukuma. Most of the people understand or speak Luganda, a local Bantu language dialect of the Baganda, the indigenous tribe (Kaye, 2006). According to the village representative the people of Busukuma are warm and hospitable and they tend to look at life in a rather positive way. The villagers usually live very scattered from each other, but have a lot of social contact and are always ready to help and support each other. During the weekend people often meet in the churches and mosques. Busukuma's population varies in ethnicity; most villagers are Christians, but there is also a small group of Muslims present. Due to their religion, people work six days a week and have a day off on Sunday. On this day people come together to sing religious songs. A dance group is also present in the village. The social contacts and religious activities give villagers the opportunity to cope with problems interfering with the quality of life, such as malaria (Kaaya, personal communication).

Livelihood. In Busukuma the majority of the villagers are small-scale peasant farmers whose main source of income is sales of food and crops (Kaaya, personal communication). Their principal activity during the day (in the morning and evening) is agricultural; cultivating crops like sugarcane, maize, sweet potatoes and Matoke bananas, which is their main food. These crops are harvested by hand with traditional hand tools and farmers are dependent on the rain for watering their land. Villagers do not have regular income; how much they earn is

seasonally dependent, often resulting in poverty when harvest fails. The crops that are harvested are mainly used for own consumption and the rest is sold (Kaaya, personal communication). There are no markets present in Busukuma and therefore products are sold on the main road.

Malaria has a great economical impact on the lives of the people in Busukuma. People mainly grow their crops on subsistence basis, and the little they earn is often spent in an attempt to get rid of malaria. Sometimes people cannot afford to pay the high medical bills. To cope with this problem they sell or lend out some of their resources, which often leads to hunger and strengthens the malaria-poverty trap. Malaria is therefore experienced as a very stressful event in Busukuma.

Daily routine. The villagers go to bed around 8:00 and 9:00 p.m. All family members get up between 6:00 and 6:30 a.m. At that time it is dusk, since the sun actually rises at 7:00 a.m. All family members then participate in working on the land. Since *An. gambiae s.s.*, the main malaria vector, only bites during the last four hours of the night, early risers (before dusk) are at risk of being bitten during agricultural work. Sometimes, people sleep outside during special occasions, for example night prayers (Kaaya, personal communication). The risk of getting bitten is higher outside. People take only two meals a day; lunch at 2:00 p.m. and supper around 8:00 p.m. and they eat together as a family.

Education. The primary school in sub-county Busukuma is located in Namulonge and can easily be reached by the children of the village. School hours are between 8:00 a.m. and 4:00 p.m. The minority of the children attend school and this mainly depends on the availability of money within the household (Kaaya, personal communication). Nearly 1.5 times more boys attend primary school than girls, which implies that girls' education is hampered. Since few people have attended primary school, a high number of illiterate people are present in the village, whereby it is assumed that this results in a lack of awareness on diseases like malaria and on how to combat them.

Gender roles. In Busukuma the heads of the household, mainly the men, make most decisions, about for example, health and finances. It is possible that these gender roles will influence the implementation of certain intervention methods, such as the use of bed nets, in the sense that only men will use them. It is important that this possible gender inequality is taken into account. Both men and women work on the land. The women and grandparents are responsible for

the cooking and taking care of the children and these family members are generally the first to take action when children fall ill of malaria. When parents are suffering from a disease, the children are mainly responsible for getting drinking water from the well and taking care of daily activities. It happens that children are taken out of school for these activities and this mainly happens to girls (Kaaya, personal communication), thereby strengthening gender inequality.

Health. Many people in Busukuma face health problems, which are mainly caused by the combination of poverty, bad nutrition and water, and diseases like malaria, including a lack of knowledge on how to combat them. There are no cases of HIV/AIDS reported at this moment (Kaaya, personal communication). However, 60% of the population does suffer from malaria, which is present all year round, creating a severe health impact. Malaria has greatly affected their well being, with women and children suffering the most. Malaria is known in the village as a very bad disease that has left most of the villager's relatives and friends dead (Kaaya, personal communication). The village representative mentioned that at one point five people died from malaria within a period of three weeks.

There is a lack of knowledge present on malaria, however, the villagers do realise mosquitoes are malaria vectors. Therefore, they tend to remove stagnant water and close their doors and windows early, in order to prevent mosquitoes from entering. They also remove bushes but this is not found to be an adequate prevention method thereby strengthening the lack of knowledge statement.

Health seeking behaviour. For treating the disease, many villagers cannot afford proper medicines and resort to traditional healers, which usually provide local herbs that are not effective (Kaaya, personal communication). When finances do allow proper medicines, the villagers tend to buy them at the local shop, where they are cheaper, instead of visiting the health centre. The amount of anti-malarials bought depends on their level of income. Therefore, it is assumed that the treatment may not be completed due to an insufficient supply of medicine. Furthermore, a delayed cure is also caused by seeking treatment at a later stage of the disease, possibly due to a lack of finances and the belief that modern medicines are a final resource.

Only 12 out of 241 households are able to afford proper treatment and have the ability to buy bed nets (Kaaya, personal communication). These households have relatives in the capital Kampala who give them financial aid. However, not only the costs, but also the availability of essential anti-malarials for the treatment of

such common diseases as malaria is a problem. Furthermore, the villagers spent a lot of time attending to the sick resulting in an inability to get involved in income generating activities, which leads to more poverty.

Continuing action. Although the government and non-governmental organisations take a lot of action against malaria in Uganda, the villagers of Busukuma are not familiar with these actions at all. Nobody has yet paid attention to the malaria problem in the village (Kaaya, personal communication). Therefore, it is assumed that any of the possible actions can be implemented and will probably lead to a reduction in the incidence of the disease.

5. Factors influencing environment and behaviour

There are many different factors influencing the environment and people's behaviour concerning malaria prevention and treatment, for example the availability and accessibility to resources, the educational status of the people, but also certain myths and beliefs that exist about the disease. These factors can either have a positive or negative influence on the implementation of certain methods. This influence is taken into account in the chapter 'Decision Making' where appropriate prevention and treatment methods will be selected, by balancing the advantages and disadvantages, for making the action plan suitable for implementation. Therefore, this chapter provides an overview of general factors concerning environment and people's behaviour and outlines specific factors related to certain prevention and treatment methods.

5.1 General factors concerning environment: accessibility and availability

There is often a lack of accessibility and availability in rural areas to public health care facilities providing resources for prevention and treatment methods. Long distances to the health care facilities (Amuge et al., 2004), poor organisation in facilities resulting in long waiting times, delays in opening times of clinics, poor attitudes and poor communication skills of health workers, and very high client to staff ratios, all hamper the process of seeking help. Quality issues affecting the use of health services include inaccurate diagnosis, inappropriate prescription and advice, continued use of ineffective drugs and drug stock-outs. These stock-outs exist due to underestimation of requirements, lack of resources, delays in release of funds and monopoly of drug supply by government stores (Hill and Kazembe, 2006). Due to these mentioned constraints, people resort to traditional healers and untrained health workers, resulting in an inaccurate approach to prevent and treat malaria.

The nearest health centre lies in Kyapa in the sub-county Busukuma and is easily accessible. Too little knowledge has been obtained on the quality of the organisation of the health centre. It is known that ten people are employed, including two nurses. Although no information on communication skills of health workers is present, the nurses seem to have an adequate medical knowledge on treatment of the disease and it is assumed that this results in accurate diagnoses. However, they are probably not familiar with the preventive use of anti-malarials. Resistance is reported for some of the anti-malarials prescribed by the nurses,

such as SP and Chloroquine, but it is not known if the nurses are aware of this problem. Quinine is also used, for which resistance has not yet been reported. Anti-malarials from the local shop in Busukuma are cheaper. In this shop a person is present, who helps with information on and prescription of anti-malarials. No governmental funding is received and the level of income is low, resulting in anti-malarials and bed nets being too expensive for most villagers. This inhibits the proper use of treatment drugs. Furthermore, literature shows that children often do not receive proper doses of the prescribed drugs. This is due to the sharing of drugs with other siblings, but also the discontinuation of the treatment when signs of recovery are showing.

Thus it can be concluded that the economical constraints of the villagers seem to be the most important reason in Busukuma for not being able to control the malaria problem. Therefore, the villagers retreat to traditional healing methods which are not effective.

5.2 General factors concerning behaviour: knowledge, myths and beliefs

What kind of knowledge, myths and beliefs exist regarding malaria prevention and treatment largely depends on the socio-economic status, the rural-urban ratio, education level and all kinds of cultural factors (Hill & Kazembe, 2006).

Kengeya-Kayondo et al. (1994) have shown that knowledge about malaria is often not accurate. In their research they found that “omusujja”, the word used for malaria in the local language, covers a broad symptom complex that does not consistently correspond to the clinical case definition of malaria. Therefore, the diagnosis of malaria is not always consistent. Furthermore, when a lack of knowledge and awareness exists many myths and wrong beliefs are present.

Studies (Kengeya-Kayondo et al., 1994) show that beliefs, concerning the cause of malaria, that rural women can have in Uganda are drinking dirty/un-boiled water, staying near somebody with malaria, supernatural forces, eating fresh maize or sweet fruit such as mangoes, pineapples and passion fruits, sexual transmission, the foetus in the womb, or transmission from animals to humans. However, according to Nuhawa (2002), most people in Uganda do have the right knowledge on the cause of the disease, namely that mosquitoes transmit it, but that the transmission model of people differs from biomedical facts.

Problematic with these myths and beliefs is that they can have a negative effect on behaviour concerning malaria prevention and treatment. For example the perception that people in Uganda have according to Nuwaha (2002), is that public health services are of low quality. This perception is however mostly the result of under dosing of anti-malarials and increased drug resistance, leading to non-cure as well as chronicity of the symptoms. Secondly, the belief exists that some aspects of malaria, e.g. seizures, are best treated by traditional methods. Furthermore, mild fever is seen as a normal sign of pregnancy, which will heal by itself. Finally, malaria control is perceived as a governmental responsibility and deemed unachievable due to the abundance of mosquitoes in the community (Nuwaha, 2002).

In Busukuma, diagnosis of malaria by the villagers themselves is made after being bitten by mosquitoes and having fevers. According to the nurses, people diagnose quite accurate and do this in an early stage. However the villagers visit the health centre at a later stage. This behaviour is probably due to a lack of money, resulting in a delayed cure. Among the villagers no specific myths exist and it seems they have an accurate knowledge on the mosquito as malaria vector and where this vector breeds (Kaaya, personal communication). They use small-scale prevention methods at household level, such as removing stagnant water and closing doors and windows early. However, these methods do not seem to work effectively, seen in the remaining high incidence of malaria. Either these methods should be put to more efficient use or other prevention methods should be introduced in dialogue with the villagers. The villagers seem to know the positive effect of bed nets; however, a lack of money prevents them from acquiring them. The impression is that they are not aware of other important prevention methods, such as IRS and IPT, and this could be due to a lack of knowledge caused by illiteracy.

It can in general be concluded that a lack of finances and a lack of knowledge on other intervention methods are the main factors leading to an improper approach to combat malaria.

5.3 Factors concerning prevention methods

Factors concerning the use of Insecticide Treated Nets. In literature, many factors exist to why people might not be able or not want to use ITNs as a prevention method for malaria. People, for example, think ITNs are hot to sleep under and they are afraid of suffocation by ITNs, because the nets resemble a structure put

over dead bodies during burial. Furthermore, they are afraid of poisoning due to the chemicals used in nets and, especially women perceive the chemicals to be associated with poor pregnancy outcomes and to have an effect on children. Often people belief that nets are expensive, do not prevent malaria and are therefore not worth the costs. Besides, there is not much opportunity for people to buy ITNs due to low accessibility, low availability and economical constraints. Therefore there is no instilled use of ITNs. The unequal balance of power between men and women leads to social inequalities and paves the way for women's vulnerability to malaria and other infectious diseases (Mbonye, 2005). Finally, there are no projects and programmes that promote the re-treatment of bed nets (WHO, 2007a).

The main reasons that ITNs are not used in Busukuma are probably a lack of money, no instilled use and no programmes promoting the use and re-treatment of ITNs.

Factors concerning the use of Intermittent Preventive Treatment. The use of IPT as prevention method is influenced by several factors as stated in literature (Mubyazi et al., 2005; Hill & Kazembe, 2006). For example, women are reluctant to take medicines during pregnancy because of concerns for potential effects on the unborn child. Late antenatal attendance is also a barrier to delivering the second dose of the effective anti-malarial. This is probably due to a limited access to information about the benefits of IPT and women are often uninformed or misinformed about the standard dosage of the anti-malarial required. Therefore, they perceive ineffectiveness of the drug and thus retreat to other drugs. Furthermore, they perceive a relationship between the anti-malarial side effects and HIV infection. Finally, some women reported developing adverse reactions after using the anti-malarial and tend to throw away the medicine tablets after leaving the antenatal clinic.

All the above stated factors could be of importance to the lack of IPT use in Busukuma. Furthermore, it is assumed that the nurses in the health centre are not familiar with this prevention method due to only mentioning the prescription of anti-malarials to pregnant women already suffering from the disease.

Factors concerning the use of Indoor Residual Spraying. Many factors influence the behaviour of people concerning the use of IRS (Najera & Zaim, 2001; WHO, 2001). It is necessary to provide safe use, transport and storage of the insecticides and other appropriate precautions to reduce the risk of contamination

with other toxic doses and contamination of the environment. This requires a lot of organisation and external funds, on which sustainability depends, which may be problematic to achieve. Furthermore, people might think that mosquitoes are resistant for certain insecticides, making IRS an ineffective prevention method. They need to accept the necessity of IRS, since it requires the movement of all furniture from the walls and be able to dedicate themselves to the task for it to be a sustainable method. Finally, it is necessary they do not sleep outdoors, since exposure to the insecticides, and thus protection against malaria, is only inside.

All the above stated factors may influence the behaviour of the villagers of Busukuma concerning the use of IRS. Especially the lack of (governmental) funds and organisationally difficult implementation of the method are important influents on the use of this method.

Factors concerning the use of Environmental Management. It is difficult for local communities, such as Busukuma, to start an EM program themselves, especially in the short term, due to many factors (Utzinger et al., 2001; Lindsay et al., 2004). These include large costs, difficulty in attracting labour force, the necessity of training local people and the need for community participation. Furthermore, effective dialogue is required between the local communities and the health sector, settlement planning sectors, environmental concerns, and academic institutions, for EM to be successful.

Factors concerning the use of other prevention methods at household level. A lack of awareness is the main cause of the non-use of other prevention methods at household level which include disposing of empty tins and containers, covering rainwater tanks, pouring oil on or draining of stagnant water, closing windows and doors early, closing gaps and holes in walls/roof/etc. of the houses, burning mosquito coils and eating a proper diet. For pouring oil on stagnant waters, burning mosquito coils and eating a proper diet costs are involved and therefore, economical constraints limit the implementation of these methods (Mbonye, 2005).

In Busukuma some of these small-scale prevention methods at household level are used, such as draining of stagnant water and closing windows and doors early. This is however not effectively and widespread applied, probably due to a lack of knowledge and money.

5.4 Factors concerning treatment methods

Factors concerning the use of Home Based Management (HBM). The success of implementing HBM techniques depends on many factors (Kilian et al., 2003). It is possible that stocks of anti-malarials run out. Furthermore, pre-packed forms of anti-malarials have higher costs and when treatment needs to be sought that isn't free of charge, the mother has to wait for the husband to give permission to send the patient to get medicines. It also happens that the HBM strategy does not address people's cultural perception and understanding of illness. Thus treatment delay is likely to persist when caretakers suspect 'non-mosquito illnesses'. Finally, there is a lack of local terminology and adaptation of the information and training material to the local situation when introducing HBM.

In Busukuma, diagnosis of malaria is made early and quite accurate. However, due to lack of money, self-treatment and traditional healing are first explored before seeking help from the health centre, inevitably resulting in a delayed cure.

Factors concerning the use of Artemisinin-based Combination Therapy (ACT). ACT is recommended by the RBM (2007b) to treat malaria. However, certain factors influence the use of ACT. First of all, Artemisinin derivatives may be misused in view of their value in the treatment of severe malaria. Secondly, Artemisinin derivatives are expensive. Drug resistance may also occur, but there is still a lack of evidence for ACT delaying resistance in areas of high transmission.

The above mentioned factors are not applicable for the situation in Busukuma since Artemisinin derivatives are not available in the health centre or local shop of Busukuma.

Factors concerning the use of other treatment methods at household level. Self-treatment and going to traditional healers is influenced by lack of knowledge and economical constraints and may lead to a delayed cure. When people have the financial possibility to do so they buy modern medicines, however, lack of knowledge on using these medicines can result in non-effective or discontinuation of the treatment. These factors are applicable for Busukuma.

6. Decision making

From the report a clear view can be obtained of the malaria problem in Busukuma. Throughout the year there are mosquitoes of the family *Anopheles* in the village which have the ability to transmit the disease from one person to another. There are many people in the area of the village which suffer from the disease and thus can be a source of transmission. Throughout the year the temperature is always high enough for malaria transmission. In the village, swamps and a lot of puddles with stagnant water are present. Therefore, there are enough breeding sites for mosquitoes present around the houses throughout the year.

Different factors hamper the adequate prevention and treatment of malaria in Busukuma. The main factors are a lack of money and the ineffective use of existing small-scale prevention methods at household level. Furthermore, a lack of knowledge exists on other important intervention methods.

To decide on appropriate and effective prevention and treatment methods, for reducing the incidence of malaria in Busukuma, a decision has to be made between the most important prevention and treatment methods. These methods include ITNs, IRS, IPT, EM, HBM, ACT and other treatment and prevention methods at household level. To make this decision the cost-effectiveness of each method is taken into account considering the low income of the villagers and the short-term benefits that need to be created. Furthermore, the methods should fit into governmental en non-governmental action already taken. Finally, it is extremely important to take changeability of the above mentioned factors into account because they act as constraints on the feasibility of the chosen methods.

6.1 Opportunities and constraints per prevention method

Insecticide Treated Nets (ITNs). Results have shown that ITNs are cost-effective, US$19-85 per DALY averted during first implementation and US$4-10 per DALY averted during maintenance, as stated in Chapter 1.10 of this report. The Malaria Control Program (MCP) of the Government of Uganda stimulates the use of ITNs. NGOs that have been working on the prevention of malaria, by increasing the supply and demand of bed nets, are the WHO, UNICEF, Ugandan Red Cross Society (LLITN), AMREF (LLITN), RTI and NetMark USAID.

The main factor that limits the active use of ITNs in Busukuma is a lack of money, because it seems people do have knowledge on the benefits of bed nets and are said to use them if they have the financial possibilities. According to Frank Kayaa, currently only 12 out 241 household possess ITNs, since they have the required finances. This results in a reduction of malaria. The only constraint that may exist when ITNs are acquired is a lack of knowledge that might inhibit the proper use of them. This “lack” of knowledge will first have to be investigated in the 12 richer households. When such a lack of knowledge appears, it can be influenced by going into dialogue with the current user group: why do they use them this way, what will be better, etc. Discussions in and actively involvement of this user group are important for further implementation of ITNs in Busukuma.

Overall, ITNs create short-term benefits and require little organisation. It can be said that bed nets, once obtained and properly used, will reduce the number of malaria cases and deaths. Furthermore, Eckhardt (2004) states “bed nets seem to be the most effective and efficient intervention tool in countries with scarce financial resources and a population with high illiteracy rates”, as is the situation in Busukuma. In conclusion, this method seems an appropriate one for combating malaria in Busukuma.

Indoor Residual Spraying (IRS). Results have shown that IRS is cost-effective, US$32-58 per DALY averted during first implementation, as stated in Chapter 1.10 of this report. The MCP of the Government of Uganda stimulates the use of IRS. NGOs that have been working on the prevention of malaria using IRS are the RTI and AFM, the latter promoting the use of DDT.

Certain factors may influence the behaviour of people concerning the use of IRS (Najera & Zaim, 2001; WHO, 2001), such as the thought that mosquitoes are resistant for certain insecticides, lack of money, and the risk of contamination with other toxic doses and contamination of the environment. Additionally, IRS does not directly prevent people from being bitten, since mosquitoes only rest on the insecticide treated wall after a blood meal. Thus IRS generally only kills the mosquito after, and not before, the infectious bite. IRS has to be done on a regular basis, in general a few times each year. Therefore IRS needs a good organisation and qualified people, which are factors difficult to achieve in Busukuma. Furthermore, a lack of (governmental) funds also limits the possibility of implementing this method. The changeability of these limiting factors is too low and therefore this method will not be part of the action plan.

Intermittent Preventive Treatment (IPT). This approach has been shown to be safe, inexpensive and cost-effective, US$4-29 per DALY averted during first implementation, as stated in Chapter 1.10 of this report. The MCP of the Government of Uganda approves this intervention strategy and plans to integrate this into maternal services and to create demand for these services. The WHO, UNICEF and AMREF also stimulate this prevention method.

In Busukuma there is a health centre which should be able to implement the IPT method for pregnant women. However, this is not the case now, since pregnant women only use anti-malarials to treat malaria in stead of taking them preventively. It is assumed that this behaviour is caused by a lack of knowledge on this method, such as limited access to information about the benefits of IPT, and lack of good information about the dosage of the anti-malarial and its side-effects. Another important constraint in Busukuma is probably lack of money. Furthermore, this method is constraint by broader weaknesses within the overall health system of Uganda, such as inadequate resources which limit the implementation of this method for all pregnant women. Due to the low changeability of the above mentioned factors, IPT is not recommended to be one of the first actions for malaria prevention in Busukuma.

Environmental Management (EM). The cost-effectiveness for EM are relatively high for the first 3-5 years of implementation, US$524-591 per DALY averted during first implementation, as stated in Chapter 1.10 of this report. This makes EM less suitable for malaria control. The NGO EHP is working on EM.

Large scale EM is difficult to implement for a small rural village like Busukuma, due to the large costs it incurs, difficulty of attracting labour force for the implementation and lack of knowledge and skills for adequate EM. The feasibility of introducing EM is low, for example because large-scale draining of stagnant water is too expensive and requires excellent infrastructure. Furthermore introducing fish, which eat mosquito larvae, is difficult due to several ecological limitations and continuous debate. Therefore EM will not be part of the action plan.

Other prevention methods at household level. Other prevention methods at household level are cheaper than the above mentioned ones and feasible for implementation. They mainly entail reducing the number of breeding sites of mosquitoes, for example by disposing of empty tins and containers and covering rainwater tanks. These methods can easily be applied; however, the villagers of

Busukuma are not familiar with some of the methods and other methods are not effectively implemented. This is probably caused by a lack of awareness on specific prevention methods and a lack of devotion, which limit consistent implementation. This behaviour can be changed by going into dialogue with the villagers and discussing how and why they use these methods and the results they see. From there a discussion can follow on increasing the effectiveness of the used methods and introducing benefits of new ones throughout the village. Therefore, these methods will be further outlined in the action plan.

6.2 Opportunities and constraints per treatment method

Home Based Management (HBM). HBM entails educating community resource people and is cost-effective, approximately US$4 per case treated during first implementation and US$0.37-1.36 per case treated during maintenance, as stated in Chapter 1.10 of this report. The government aims at institutionalizing HBM at household level and the NGO AMREF also focuses on HBM.

Diagnosis of malaria is made early and quite accurate in Busukuma. However, high costs of anti-malarials involved in HBM, limit the successful implementation of this method in Busukuma. Besides this factor, it is possible that other factors constrain the implementation of HBM, like stocks of anti-malarials running out and lack of local terminology and adaptation of the information and training material to the local situation when introducing HBM. Due to the difficulty of increasing the financial possibilities of the villagers, this method is not recommended to be one of the actions concerning the malaria problem in Busukuma.

Artemisinin-based Combination Therapy (ACT). This approach is a cost-effective method, approximately US$12 per DALY averted during first implementation, as stated in Chapter 1.10 of this report. ACT is recommended by the NGOs WHO and UNICEF as a method to treat malaria.

There are factors influencing the use of ACT in Busukuma, like lack of availability of Artemisinin derivatives in the health centre or local shop. Furthermore, ACT has the disadvantage that it is more expensive than non Artemisinin-based combinations, and these costs cannot be afforded by the villagers who have limited financial possibilities. These factors make ACT an unfeasible method in the control of malaria in Busukuma.

Factors concerning the use of other treatment methods at household level. The main reason villagers seek self- treatment or traditional healing, methods which are not successful, is lack of money. When people have the financial possibility to do so they buy modern medicines, however, lack of knowledge on using these medicines can result in non-effective or discontinuation of the treatment. Due to the difficulty of increasing the financial possibilities of the villagers it is hard to change this health seeking behaviour. However, attempts should be made to change this behaviour by promoting the use of anti-malarials as prevention and treatment drug. This should especially be done with the involvement of the nurses at the health centre and the person at the local shop, due to the position these people have in prescribing and giving information on the use of medicines.

Final decision. After discussing all the possible prevention and treatment methods to control malaria, a decision must be made on appropriate methods for the village Busukuma. Since a lack of money is a major constraint that limits all possible intervention methods, and since increasing these financial possibilities is difficult, solutions need to be found that side-step this problem. Therefore, the only methods that can be used in this early stage are free-of-charge distribution of ITNs through participation of the government or an NGO, other smaller-scale (existing) prevention methods at household level, and changing health seeking behaviour by promotion of anti-malarials as prevention and treatment drug.

The one-time distribution of ITNs should be accompanied by an investigation of the 12 households using bed nets, to get a view on the level of knowledge concerning the use of these nets. In collaboration with these households a plan is designed, with emphasis on interaction between the villagers and the organisation implementing this method, on the effective use of ITNs. Together with the introduction and effective promotion of other prevention methods at household level, like disposing of empty tins and containers, covering rainwater tanks, draining stagnant water, closing windows and doors early and closing gaps and holes in walls/roof/etc. a reduction in the incidence of malaria is assumed. Hopefully, this first reduction in the incidence of malaria will reduce the health, economical and social impact the disease has on the villagers whereby opportunities are created to enhance the implementation of other methods.

7. Recommendations

This chapter discusses recommendations that need to be considered for the successful implementation of the above selected intervention methods: the distribution and use of ITNs, other prevention methods at household level and changing the health seeking behaviour of the villagers. For the implementation of all three prevention methods, the following steps need to be taken.

Coordination. One person should be in charge to ensure the overall coordination concerning the implementation of the decided intervention methods.

Fundraising. There are costs related to the implementation of the decided intervention methods that must be kept in mind, such as costs for materials, transport, meals, mobilisation, education, etc. To finance these costs, money needs to be collected by fundraising. This should be done through NABUUR by creating attention for the money problem in Busukuma, for example, by contracting a group of volunteers that want to actively help by fundraising or by contacting villages in the Netherlands to “adopt” Busukuma to establish a long-term dedicated relationship.

Partners. Contact has to be sought with local NGOs or Community Based Organisations (CBOs) working on malaria in Wakiso district. These NGOs or CBOs will need to be motivated on working on malaria prevention and treatment in Busukuma. So far, three organisations have showed interest in co-operation for this project:

- Huyslinci Community Initiative, contacted via NetMark. This small NGO is working on a Child Health Project whereby two of the four objectives target malaria prevention and treatment.
- Ngongolo CBO, contacted via NetMark. This CBO is working on malaria treatment and campaign programmes targeting orphans, widows, youths and other vulnerable people.
- Uganda Red Cross, not implementing malaria control activities in Wakiso at the moment. However, they are active in distribution of ITNs in other areas and have a number of volunteers in Wakiso district willing to partner.

Overall coordination and implementation of the action plan should be preferably done with a staff member of NABUUR in collaboration with one of these NGOs,

which would be responsible for the successful implementation locally. Therefore, contact with these organisations is important for the design of the action plan. Furthermore, they need to show trust and commitment to the community by involving them as much as possible.

When collaboration with an NGO is established that can't cover the entire implementation of the action plan, additionally a local person/group should be appointed for the overall coordination and successful implementation of the action plan locally. This will ensure interconnectedness between the different elements of the action plan.

Health workers. The use of ITNs and anti-malarials should be promoted in collaboration with traditional and private health care providers. An investigation should be conducted on the level of knowledge the nurses and the person at the local shop have on the use of anti-malarials as prevention and treatment drug. From there, a decision should be made on how to complement their knowledge, hopefully resulting in improvement of malaria diagnostic and treatment skills. Furthermore, traditional healers need to be sensitised on anti-malarials and their safety and effectiveness (Eckhardt, 2004). Health workers are important to target, since they are also good in generating trust and can take advantage of this by helping people to change their behaviour.

Villagers. The villagers of Busukuma should be involved in the early stage of making decisions on how to best address issues of prevention and treatment of malaria. Further knowledge building should especially be done among mothers and grandparents since they play a key role in taking the first step to seek help and make the most immediate decisions that affect the well-being of the children and themselves. Efforts should be made to emphasise that the villagers themselves are the primary players and the ones who benefit the most in the control of malaria. Therefore, their involvement is necessary. Furthermore, knowledge building on malaria control should be done in such a way that it will lead to the incorporation in the daily life of the villagers. Involvement and knowledge should be created early to help build a basis of understanding, allow resources to be mobilized, increase the motivation and make the control program successful and sustainable in reducing the incidence of malaria.

Discussion group. To realise this above mentioned involvement it is important to create a discussion group that correctly represents the village Busukuma. Such a group could consist of, for example, a nurse, a young woman, an elder, a

community council member, and some other villagers, led by someone who enhances the implementation of the project, such as an NGO-member or another volunteer. In discussion with these villagers, insight has to be obtained on the knowledge on malaria control that exists, their beliefs, their use of prevention and treatment methods, health seeking behaviour and why these methods work or don't work. When more insight has been obtained about the current situation regarding malaria, input by the discussion leader is necessary to open the discussion on the use of new prevention and treatment methods. This discussion process is needed to ensure that the knowledge that is already present in families is extended, and that the intervention to be implemented is suited to the present situation, knowledge and perceptions. Additionally, discussion should focus on how, in an interactive way, knowledge, skills and health seeking behaviour concerning effective malaria control can be ensured. This interactive process could for example be done in creative ways with drama, song and/or dance, whereby malaria concepts are explained.

Behavioural change and knowledge concerning the implementation of the three decided intervention methods should be ensured by focussing on:

Insecticide Treated Nets (ITNs). A dialogue needs to be started among the households that use bed nets (apart from the already existent discussion group). Through these discussions insight has to be obtained on the current use and perceptions concerning bed nets. This insight can be used for further implementation of the method, whereby it is important to build on the knowledge that the people already have. Thus, additional knowledge can be provided on how to appropriately use ITNs for prevention of malaria, to introduce the concept that children and pregnant women are the most vulnerable groups and need to be the first to sleep under ITNs, to explain what benefits ITNs create, to reassure villagers that ITNs are not dangerous and are well worth the cost and to emphasize the cost savings of using the free ITNs preventively as opposed to the high cost of malaria treatment.

Other prevention methods at household level. A dialogue should be started among the villagers concerning the prevention methods they already use and what effect these methods have. The effectiveness of these methods, such as the draining of stagnant water and the closing of doors and windows early, should be researched. The focus should be on building on the already existent knowledge and behaviour, extending and improving it where necessary. Furthermore, additional knowledge should be created on the breeding places of mosquitoes to

promote new prevention methods, such as the disposing of empty tins and containers and the covering of rainwater tanks. The misconception of bushes being a breeding place of mosquitoes should be addressed and the use of mosquito coils to repel malaria mosquitoes should be introduced.

Changing health seeking behaviour. The use of anti-malarials as prevention and treatment drug should be promoted, to change the health seeking behaviour of the villagers. To make this change possible it is important to understand the existing health seeking behaviour in more detail of the villagers and their reasons for this behaviour. From there, it is first of all needed to emphasise the importance of early and effective treatment of malaria by anti-malarials. Additionally it is necessary to discourage self-treatment and traditional healing due to the danger of untreated or incomplete treated malaria. Furthermore it is important to educate the nurses and person in the shop on the preventive use of anti-malarials and reported resistance of mosquitoes against certain anti-malarials. Finally, it is important to address the misconception that fever is a normal sign of pregnancy and to recognise the signs and symptoms of malaria at different stages.

All above mentioned topics should be communicated with active involvement and interaction of the villagers, such as active participation in the discussion group. To further work on improving the malaria control across every household of the community, interactive drama, song and dance local groups could be used. The church is also another powerful structure that can advocate for malaria control. The advantage of using communication through drama, song and dance is that all villagers can be reached in a short time and in an appealing and understandable way.

Furthermore, information materials such as brochures, posters, leaflets and cards can provide simple instructions and should be actively used by the participating organisations, nurses and health workers when working with the villagers. Very important is to use appropriate and understandable language, in this case Luganda, with local terms being used to ensure that messages are clear. It is important to use culturally appropriate methods tailored to their beliefs. As far as possible, printed messages should include pictures, so they can be understood by individuals who are illiterate. By designing these messages it should further be kept in mind that they have to be:

- Accurate, feasible and relevant
- Simple and easy to understand

- Easy to remember, conveying only one or two ideas
- Positive, to encourage positive behaviours and use of effective products
- Specific and action-oriented
- Sensitive to local cultural beliefs

With having made the decisions concerning the effective intervention methods and recommendations for appropriate implementation of these methods, an action plan can be formulated based on this information.

8. Action Plan

According to the previous chapters (6 and 7) three intervention methods need to be implemented in Busukuma. These methods are:

- The introduction and distribution of ITNs
- Other prevention methods at household level:
    - disposal of empty tins and containers
    - covering rainwater tanks
    - draining stagnant water
    - closing doors and windows early
    - closing gaps and holes in walls/roof/etc.
- Changing health seeking behaviour by promotion of the use of anti-malarials as prevention and treatment drug

For the successful implementation of all three prevention methods, the following steps need to be taken:
1) Overall coordination.

2) Fundraising: costs are involved for the overall implementation, but also for each different method, such as materials, transport, meals, distribution points, mobilisation, etc. Therefore money needs to be collected. This should be done through NABUUR by creating attention for the money problem in Busukuma, for example, by contracting a group of volunteers that want to actively help by fundraising or by contacting villages in the Netherlands to “adopt” Busukuma to establish a long-term dedicated relationship.

3) Establish a partnership with a NGO working on malaria control in Wakiso district. Three different organisations in the Wakiso district are actively involved in the prevention and treatment of malaria. These are Huyslinci Community Initiative, Ngongolo CBO and Uganda Red Cross. They have already shown their interest in collaborating concerning the activities in Busukuma. These NGOs should be responsible for 1) the overall coordination of the implementation of the project in collaboration with the overall coordinator, 2) the actual implementation of the methods, 3) going into dialogue with the villagers (discussion group) and 4) building on the knowledge which is already present in Busukuma concerning malaria control (drama, or door to door visits).

When a partnering NGO cannot cover the entire implementation of the action plan, additionally a local coordinator should be appointed for the overall coordination of the implementation of the project.

4) Health workers: Investigate the level of knowledge the nurses and the person at the local shop have on the use of anti-malarials as prevention and treatment drug. From there, a decision should be made on how to complement their knowledge, hopefully resulting in improvement of malaria diagnostic and treatment skills:

- Promote the use of ITNs and anti-malarials in collaboration with traditional and private health care providers.
- Sensitize traditional healers on anti-malarials and their safety and effectiveness.

5) Establish a discussion group for the exchange of knowledge and experiences concerning malaria control, especially concerning the below proposed intervention methods. Such a group could consist of, for example, a nurse, a young woman, an elder, a community council member, and some other villagers, led by someone who enhances the implementation of the project, such as an NGO-member or another volunteer. It is desired that discussions focus on the three intervention methods, the current health seeking behaviour and the already used prevention and treatment methods. In addition to the discussion group it may be possible to form school based malaria clubs in which children can pass on the necessary information to their parents (organising poetry competitions).

For each specific intervention method, all steps that need to be taken are explained in more detail. The different methods are discussed separately; however, it is desirable to approach the action plan as a single entity.

8.1 Insecticide Treated Nets (ITNs)

Goals

- To give people access to bed nets
- To ensure that they are used correctly

Steps to be taken

1) Ensure overall coordination of introduction, organisation and distribution of ITNs, by the partnering NGO in collaboration with a NABUUR facilitator.

2) Ensure that the money collected from fundraising is directed towards introducing bed nets. This should include funds needed to facilitate this process, involving costs for materials, transport, meals, distribution points, mobilisation, etc.

3) Do a survey to investigate the exact amount of villagers that need an ITN.

4) Start a discussion group within the community, consisting of families which have different knowledge and experiences with the use of bed nets. It is important that some of the households which have already acquired ITNs are actively involved in these discussions. Discussed should be:

- How these households use the ITNs, the difficulties they have encountered
- The perceptions considering bed nets among the villagers
- How to best introduce the bed nets among the villagers. Advised is to do this through door to door visits and further education as explained in steps 5 and 6.

5) Distribute ITNs to the whole community through door to door visits. This will hopefully be done free of charge; however, if nets are too expensive to distribute to all villagers, the distribution needs to cover a specific vulnerable group: pregnant women and children. During these visits short explanations should be given on the best way to hang up/use the nets.

6) Educate the villagers on appropriate use of ITNs: Fill the gaps, as learned form the discussion group, on what people do not yet know about malaria transmission. It is advised to do this through staging interactive drama, song and/or dance shows to promote the use of ITNs.

Suggested tasks and responsibilities

- NABUUR's facilitator, for the coordination from the Netherlands (e.g. fund raising) and collaboration with the local NGO (or appointed coordinator). Together they are responsible for the overall coordination and implementation of the method.
- NGO/volunteers, to research the amount of bed nets needed, to distribute these nets and to make sure they are used correctly.
- Discussion group, to exchange knowledge and experiences.
- Drama/song/dance groups, to promote the use of bed nets.

Time

Nets need to be distributed As Soon As Possible (ASAP). When nets are available a hang up campaign needs to follow immediately.

8.2 Other prevention methods at household level

Goals

- To reduce the number of breeding sites
- To keep the mosquitoes outside the house

Steps to be taken

1) Ensure overall coordination of the implementation of the prevention methods at household level by the partnering NGO, or the appointed local coordinator, in collaboration with a facilitator of NABUUR.

2) Allocate a small part of the fundraised money towards the facilitation of the whole process and finance the materials needed for the coverage of rainwater tanks and closing of gaps and holes in walls/roof/etc. of the houses.

3) Do an assessment through the discussion group to gain insight in measures already taken at household level, what effect they have and if they can be put to more efficient and effective use. In this group additional prevention methods can be discussed. Finally, it is important to discuss how the knowledge gained from the discussion group can be shared with the rest of the villagers through an interactive process to further learn and build on existing practices. Advised is to do this through door to door visits as explained in the following step.

4) Do door to door visits to further gain knowledge on the current prevention methods used at household level. Complementing the existing methods is possible by going into dialogue with the villagers on improving/strengthening these methods and introducing additional household prevention methods. Attention should go towards:

- The disposal of empty tins and containers around the house, which could be a source for stagnant water and thus breeding sites for mosquitoes.
- The covering of rainwater tanks to limit the breeding sites for mosquitoes:
    - Tanks need to be covered when it is not raining and this cover needs to be easily removed when it is.
    - To cover the tanks cloth, plastic or wood can be used. It is important that tanks are covered properly whereby no holes are present through which mosquitoes can enter the tank.
    - One idea is to use a big funnel catching the water and leading it through a sieve. This prevents mosquitoes from breeding in the rainwater and filters the water before entering the tank (Figure 6).

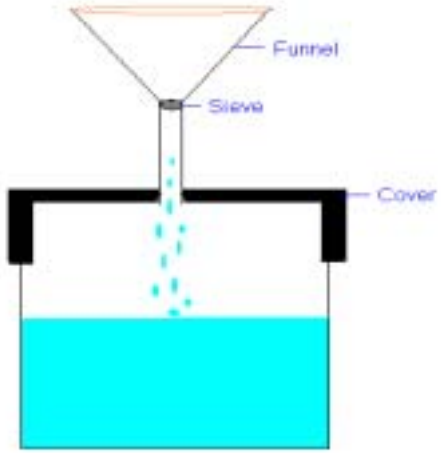

Figure 6. A drawing of a covered rainwater tank, including the use of a funnel to catch the rain.

- The draining of stagnant water to limit breeding sites for mosquitoes.
- The closing of doors and windows early to prevent mosquitoes from entering the house.
- The closing of gaps and holes in walls/roof/etc. of the houses to prevent mosquitoes from entering the house.

Suggested tasks and responsibilities

- NABUUR's facilitator, for the coordination from the Netherlands (e.g. fund raising) and collaboration with the local NGO (or appointed coordinator). Together they are responsible for the overall coordination and implementation of the method.
- NGO/volunteers, for the door to door visits, to go into dialogue with the villagers, to create active awareness and to make sure implementation is done properly.
- Discussion group, to exchange knowledge and experiences.

Time

ASAP

8.3 Changing health seeking behaviour by promotion of the use of anti-malarials as prevention and treatment drug

Goals

- To change the health seeking behaviour of the villagers

Steps to be taken

1) Ensure overall coordination of the implementation of the promotion of the correct use of anti-malarials as prevention and treatment drug by the partnering NGO, or the appointed local coordinator, in collaboration with a facilitator of NABUUR.

2) Allocate a part of the fundraised money for enabling villagers to execute the appropriate health seeking behaviour. Additional money is needed for facilitating this whole process.

3) Conduct a one day orientation workshop for the nurses and person working at the local shop, to increase their motivation and knowledge for improvement of their malaria diagnostic and treatment skills. Furthermore, active awareness should be created among these health workers on the existence of anti-malarials as prevention drug (IPT).

4) Establish a discussion group consisting of villagers with different levels of knowledge and experiences in health seeking behaviour and specifically with the use of anti-malarials. This is needed to gain further knowledge on the actual health seeking behaviour and its effectiveness. The insights obtained from this discussion group should be used to further build on the existing knowledge and practices. In the discussion, the focus should be on:

- The importance of early and proper treatment with anti-malarials
- The discouragement of the use of herbs, especially in the treatment of malaria in children
- The use and benefits of IPT

5) Do door to door visits to further gain knowledge on the current health seeking behaviour. Changing this behaviour is possible by going into dialogue with the villagers on the early and proper use of anti-malarials. Information materials such as brochures and posters can provide simple instructions and should be actively

used by the participating organisations, nurses and health workers when working with the villagers.

Suggested tasks and responsibilities

- NABUUR's facilitator, for the coordination from the Netherlands (e.g. fund raising) and collaboration with the local NGO (or appointed coordinator). Together they are responsible for the overall coordination and implementation of the method.
- A person skilled in the use of anti-malarials, to conduct the one day orientation workshop for the health workers of Busukuma.
- NGO/volunteers for the door to door visits, going into dialogue with the villagers and promoting the use of anti-malarials as prevention and treatment drug.
- Discussion group, to exchange knowledge and experiences.

Time

ASAP

Discussion

Report

During this research, information was obtained by interviewing the local representative of the village of Busukuma by MSN, Skype and e-mail. It was possible to have frequent (weekly) and efficient contact. The use of these means of communication for scientific interviewing is new. New methods offer new opportunities but are subject to new limitations as well.

A common debate is the debate on short visits to foreign countries and rural areas as a way to collect scientific data. The use of such short visits for scientific research is subject to many limitations. A long term presence is widely considered optimal, but this is impossible due to the lack of money and time. Today's ability to interview by MSN, Skype and e-mail offers the advantage that it is possible to maintain a relation with somebody far away over a longer period of time without involving heavy costs in time and money.

However, this advantage comes at a price. As the writers of this report never met the local representative of Busukuma in the flesh, it proved to be difficult to perform in depth interviewing, with adequate probing and checking the answers. This might have resulted in a lack of insight in the actual local situation. Thus assumptions needed to be made on several cases, clearly differentiated by, for example, stating "it is assumed…"

For the making of this report several people have had their input, such as the organisation NABUUR, the local representative of Busukuma, the project team and its coach and several NGOs. These parties and their inputs come from different backgrounds, perspectives and intentions. Therefore it might be that these inputs are no compatible with each other. It was the task of the project team to view all different perspectives as objective as possible and to create a report that optimally represents all different viewpoints. By having consulted all parties, consent has been obtained for this report and action plan, as an end result.

Action plan

Designing the action plan is subjected to several limitations. First of all, since there is no complete stakeholder overview, including their possibilities to take

certain actions, it is difficult to design adequate action steps for them. Secondly, the implementers of the action plan are different from the designers. Therefore, this could lead to a misunderstanding of the steps in the action plan and wrong implementation of them. The action plan will be posted in several facets on the website of NABUUR. This may have an effect on the overall connection between the different steps of the action plan. The connection between steps of the action plan and the discrepancy between implementers and designers may be overcome by the appointment of a coordinator, mediating between these groups and the actions to be taken.

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Appendices

Appendix 1: Description of the Precede/Proceed-model

For the development of the malaria prevention and treatment project, the Precede/Proceed-model (Figure 7) (Green & Kreuter, 2005) is used. This model is a framework for the process of systematic development, implementation and evaluation of health education programs. The basic assumption is the quality of life, which is not only determined by health but also by environmental influences, like poverty, violence or culture. The Precede/Proceed-model is multidimensional. As such, multiple causations concerning health and health behaviours must be evaluated in order to assure appropriate intervention.

Two principles are of importance in this model:

- The principle of participation: participation of members of the target audience is important to achieve a successful change.
- The role of the local situation: environmental factors are important as determinants of health and health behaviour.

Precede *(**P**redisposing, **R**einforcing, **E**nabling, **C**auses in, **E**ducational **D**iagnosis and **E**valuation)* consists of 5 phases:

- Phase 1: Social Diagnosis: Identify and evaluate the social problems which impact the quality of life for the target population.
- Phase 2: Epidemiological Diagnosis: Analyze health aspects of the target population.
- Phase 3: Behavioural and Environmental Diagnosis: Identify behavioural and environmental factors related to the health and quality of life of the target population.
- Phase 4: Educational and Organisational Diagnosis: Identify three types of determinants:
    - Predisposing factors: knowledge, beliefs, values and attitudes.
    - Enabling factors: accessibility, availability, skills and laws.
    - Reinforcing factors: opinions and behaviours of others, family, peers, teachers.
- Phase 5: Administrative and Policy Diagnosis: Focus on the administrative and organisational concerns which must be addressed prior to program implementation. The choice of intervention is important during this phase.

Proceed *(**P**olicy, **R**egulatory, **Organisation**al **C**onstructs in **E**ducational and **E**nvironmental **D**evelopment)* consists of 4 phases:

- Phase 6: Implementation: Implement the interventions.
- Phase 7: Process Evaluation: Evaluate the process of implementation.
- Phase 8: Impact Evaluation: Measure the program effectiveness.
- Phase 9: Outcome Evaluation: Measure change in health and social benefits or the quality of life.

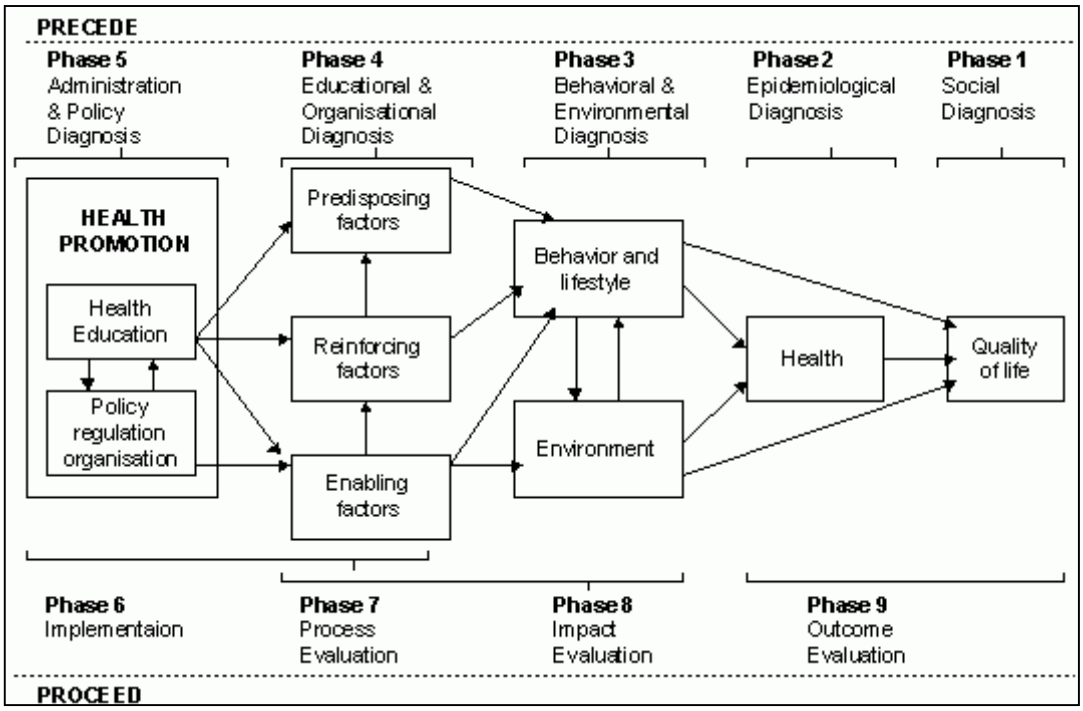

Figure 7. Graphical representation of the Precede/Proceed-model. Source: Green & Kreuter 2005.

For the overall analysis, needed to design the action plan, the Precede part of the model is used. Implementation and evaluation of the project is not done by the project team and therefore the Proceed part of the model is left out.

The Precede/Proceed-model has been applied, tested, studied, extended and verified in many published studies and thousands of unpublished projects in community, school, clinical and workplace setting over the last decade.

Appendix 2: Biology of the parasite

Malaria is caused by a one-celled organism, which spreads by infecting successively two types of hosts: humans and female *Anopheles* mosquitoes. Differently from the human host, the mosquito vector does not suffer from the presence of the parasites.

Four species of malaria parasites can infect humans under natural conditions: *Plasmodium falciparum*, *P. vivax*, *P. ovale* and *P. malariae*. The first two species cause the most infections worldwide. *P. falciparum* is the agent of severe, potentially fatal malaria, causing an estimated 700,000 - 2.7 million deaths annually (CDC, 2007), most of them in young children in Africa. *P. vivax* and *P. ovale* have dormant liver stage parasites (hypnozoites) which can be reactivated (relapse) and cause malaria several months or years after the infecting mosquito bite. *P. malariae* produces long-lasting infections and if left untreated, can persist asymptomatically in the human host for years or even a lifetime. In Uganda all four types of malaria parasites occur. The most present *Plasmodium* species is *falciparum*, responsible for 95% of the malaria cases in Uganda (WHO, 2005a).

Appendix 3: Biology of the mosquito

Anopheles lifecycle: from egg to adult. Female mosquitoes lay 50-500 boat shaped eggs each time they oviposit*, and deposit them on water (Clements, 1992), which are usually large stagnant pools. However, even water filled footsteps are large enough breeding sites. The female drops the eggs individually on the water surface where they remain floating. Depending on the temperature it takes two days to a week for eggs to develop into larvae and a fall in oxygen concentration induces their hatching (Clements, 1992). The released larvae are legless and have a clear head region. They lie horizontally, directly under the water surface and filter-feed* on small organic particles and micro-organisms.

Mosquito larvae pass through four instars* (L1-L4); the first larval stage after emergence is called L1 until the fourth, L4 (Figure 8). The growth rate of the larvae depends on temperature, nutrition and larval density (Lehane, 2005). The first three occasions that the growing larva moults, it appears almost the same as before, apart from size. The organism that leaves the fourth larval skin is the pupa*, which still remains in the water, floating at the water surface. The metamorphosis takes one or two days depending on the temperature and after this period the mosquito will emerge (Clements, 1999). Usually the mosquito remains on the water site for a while after flying off (Clements, 1992). Mosquitoes can develop from egg to adult in as little as five days but it usually takes 10-14 days in tropical conditions.

Adult: food. During the night of emergence and the first full night of adult life, mosquitoes need sugar as a food resource (Foster & Takken, 2004). For males plant juices are the only necessary food resource. Females are not obligatory nectar feeders since they can also ingest blood. However, they will die in absence of nectar or other plant sugars. Vertebrate blood, in particular the blood proteins, are usually meant for the development of the eggs and can also be used as energy source (Clements, 1992; Foster & Takken, 2004).

Mating. Mating generally occurs during twilight, between 3-5 days of adult life. Males form swarms and virgin females are fertilized when they fly through, or close to such a swarm. Females can store sperm and therefore do not need to mate after each oviposit, on the contrary only once is enough (Clements, 1999).

Female lifecycle completion. For completion of her lifecycle and for development of the eggs, blood proteins are essential, and thus finding a suitable host is crucial. Mediated by host emitted odours the female mosquito is attracted to a potential blood donor. After obtaining a full blood meal, the female will rest for a few days while the blood is digested and the eggs mature. This process depends on the temperature but usually takes 2-3 days in tropical conditions. After maturation of the eggs the mosquito has to find a suitable oviposition site, usually a pool (Allan & Kline, 1995; Du & Millar, 1999). Once a site has been found, she drops her eggs individually on the water surface. When the eggs are laid, the mosquito is again susceptible to host odours and resumes host seeking. She can bite and oviposit several times in her lifespan and the cycle repeats itself until the female dies (Clements, 1999). Females can survive up to a month but most probably do not live longer than 1-2 weeks in nature. The ambient temperature, humidity, and rain determine their chances of survival.

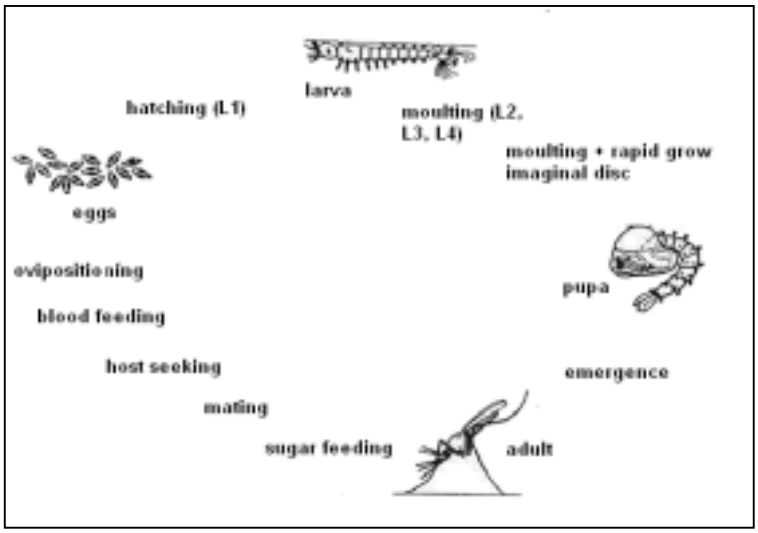

Figure 8. Anopheles life cycle. Source:website objectivistcenter.

Mosquito host seeking behaviour. There are several factors that can influence host seeking behaviour of the mosquito. Important cues affecting this behaviour are odour, temperature, humidity and visual objects (Pates et al., 2001), with odour being the most important one. Females of *An. gambiae* prefer human odour blends (Smallegange et al., 2003; Takken, 1991), while *An. arabiensis* has a preference for livestock odours (Pates et al., 2001).

Most of the released human odours are sweat born; however, breath, and especially carbon dioxide (CO_2) can be activators too. Bacterial actions on human skin secretions result in volatiles* that act as attractant (Braks & Takken, 1999).

Differences in attraction between individual persons can be due to microflora* differences and also differences in ammonia, L-lactic acid* and CO_2 emission.

Appendix 4: Information on the disease malaria

Uncomplicated malaria. The classical, but rarely observed, malaria attack lasts 6-10 hours. It consists of:

- a cold stage: sensation of cold and shivering
- a hot stage: fever, headaches, vomiting and seizures in young children
- and finally a sweating stage: sweats with return to normal temperature and tiredness

These attacks occur every second day with the tertian* parasites *P. falciparum*, *P. vivax*, and *P. ovale* and every third day with the quartan* parasite *P. malariae* (WHO, 2005a; CDC, 2007).

Malaria relapses. In *P. vivax* and *P. ovale* infections, patients having recovered from the first episode of illness may suffer several additional attacks (relapses) after months or even years without symptoms (WHO, 2005a; CDC, 2007). Relapses occur because *P. vivax* and *P. ovale* have dormant liver stage parasites (hypnozoites) that may become reactivated. Treatment to reduce the chance of such relapses is available and should follow treatment of the first attack.

*Other manifestations of malaria***.** Neurological defects may occasionally persist following cerebral malaria, especially in children. Such defects include trouble with movements, paralysis*, speech difficulties, deafness, and blindness. Malaria during pregnancy (especially *P. falciparum*) may cause severe disease in the mother, and may lead to premature delivery or delivery of a low birth weight baby. On rare occasions, *P. vivax* malaria can cause rupture of the spleen or ARDS. Nephritic syndrome, which is a chronic, severe kidney disease, can result from repeated infections with *P. malariae*. Hyper reactive malarial splenomegaly* (or tropical splenomegaly syndrome) occurs infrequently and is attributed to an abnormal immune response to repeated malarial infections. The disease is marked by a much enlarged spleen and liver, abnormal immunologic findings, anaemia, and a susceptibility to other infections, such as skin or respiratory infections (WHO, 2005c; CDC, 2007).

Appendix 5: Immunity and genetic factors

Clinical and parasitic immunity. Acquired factors are not present at birth, but are those characteristics which people can adaptively develop later, such as the development of immunity. People residing in malaria-endemic regions acquire immunity to malaria through natural exposure to malaria parasites. Clinical immunity generally develops first and provides protection against severe effects of malaria, but fails to provide strong protection against infection with malaria parasites. Such parasitic immunity is never completely reached. However, when malaria transmission is intense young children can build up immunity and be relatively protected against the disease and blood stage parasites. Therefore, the transmission intensity influences the course of development of both clinical and parasitic immunity (CDC, 2007).

The maintenance of this non-sterile state of immune protection requires continued exposure to malaria infection and a functioning spleen, since splenectomy* makes an otherwise immune protected human fully susceptible to infection and disease again. Likewise, when immune individuals leave a malaria-endemic region and reside for several years in a malaria-free region, they often become susceptible to infection and clinical symptoms if they return to the malaria-endemic region.

Immune responses to malaria. Studies (CDC, 2007) have shown that antibodies, cells and cellular factors can mediate protection in malaria. Antibodies can mediate their protective effect by multiple mechanisms. Antibodies against parasites can neutralize parasites, retard parasite development, prevent them from entering target cells and help macrophages* to efficiently engulf the parasites and infected cells. Antibodies developed against gametocytes can prevent parasite development in mosquitoes when taken up along with the blood meal. This type of immune protection is often referred to as transmission-blocking immunity*.

Some of the research (CDC, 2007) focuses on how humans acquire protective antibodies after natural exposure to malaria parasites and how it helps to control these parasites and prevent the disease. Natural Killer (NK) cells and neutrophils are first line defences against malaria, attacking malaria parasites in several ways. Macrophages are responsible for eventual clearance of parasites from the blood. Cellular immunity involving cytotoxic T cells are particularly effective in

attacking malaria parasites during the liver stage development and cytokines* released from lymphocytes enhance this process. Cytokines secreted by different leukocyte populations may also play a direct role in protection. For example, interferon-gamma* work against liver stage parasite development and activate macrophages to attack blood stage parasites. Cytokines are also responsible for the severity of the disease. A cytokine known as Tumor Necrosis Factor (TNF)-alpha is responsible for inducing high fever observed in malaria patients. The severity of the disease may vary, depending upon the level and the type of cytokines produced after malaria parasite infection.

Each of the developmental forms (liver stages, asexual blood stages, gametocytes, sporozoites) of the malaria parasite presents a different group of targets to the immune system of the infected host. In addition to this diversity of targets, malaria parasites mutate rapidly generating different variant forms such that individual antigens may differ within the same species of parasite. This ability to generate different forms and a diversity of polymorphism within the antigenic targets of the host's immune system help the parasites to evade malarial immunity (CDC, 2007).

Genetic factors that influence malaria. Innate factors are those specific characteristics of a host that are present at birth, several of them influencing malaria infection. For example, persons who carry the sickle cell trait* will be relatively protected against severe disease and death caused by *P. falciparum* malaria. In general, the prevalence of hemoglobin-related disorders and other blood cell dyscrasias*, such as Haemoglobin C*, thalassemias* and G6PD deficiency*, are more prevalent in malaria-endemic areas and are thought to provide protection from the disease (CDC, 2007). Another example of a genetic factor involves persons who do not have the Duffy receptor* on their erythrocytes*. These Duffy negative individuals, who include most of the people in West and East Africa, have red blood cells that are refractory to infection by *P. vivax* and therefore protected from infection (CDC, 2007).

Appendix 6: Resistance against insecticides and anti-malarials

Insecticide resistance. Insecticide resistance is reported to be linked on insecticide use in agriculture (Sina et al., 2001). Exposure of mosquito larvae to insecticides, targets the development of resistance. Resistance is in most cases reported to be local and directly linked to common used insecticides (CDC, 2007). The main defence against resistance is close surveillance of the susceptibility of vector populations (Brogdon & McAllister, 1998). Resistance against pyrethroids , the major insecticide on ITNs, is also detected, which is linked to the use of this insecticide in cotton plants (Sina et al., 2001). There is no evidence that ITNs induce the development of insecticide resistance.

Quinine resistance. Decreasing sensitivity to Quinine has been detected in areas of South-East Asia and in some parts of South America, where it has been used extensively as the first line treatment for malaria. There is some cross-resistance between Quinine and Mefloquine, suggesting that the widespread use of Quinine in Thailand may have influenced the development of resistance to Mefloquine in that country. Strains of *P. falciparum in* Africa are generally highly sensitive to Suinine (WHO, 2005a; 2005b).

Chloroquine resistance. Resistance of *P. falciparum* to Chloroquine appeared almost simultaneously in Colombia and on the frontier between Thailand and Cambodia. In Asia, Chloroquine resistance was initially confined to the Indochinese peninsula, until the 1970s, when it spread westwards and towards the neighbouring islands in the South and East. The advent of Chloroquine resistance in Africa occurred much later, and it took a decade to cross the continent. Today, only countries in Central America North of the Panama Canal and on the island of Hispaniola have no documentation of Chloroquine-resistant *P. falciparum*.

Amodiaquine resistance. Although Amodiaquine is generally more effective than Chloroquine against Chloroquine resistant strains of *P. falciparum*, there is cross-resistance between them. Moderate to high levels of Amodiaquine resistance have been reported from Papua New Guinea, East Africa and the Amazon basin. However, the drug continues to be efficacious in most of West and Central Africa and the northern Pacific coast of South America. Nevertheless, Amodiaquine could rapidly lose its efficacy if it is used intensively in areas in which Chloroquine resistance is widespread or very high (WHO, 2001a; 2003a).

Sulfadoxine-Pyrimethamine resistance. The SP combination was used as a replacement for Chloroquine in most countries. At the beginning of the 1980s, however, that treatment became almost totally ineffective in Thailand and neighbouring countries, and resistance to the treatment spread rapidly in South America. In 1993, Malawi was the first country in East Africa to change from Chloroquine to the SP combination as the first line drug, and other African countries followed this example in the late 1990s. Because of extensive use of this combination resistance has spread in East Africa. High levels of resistance of *P. falciparum* are found in the Amazon Basin, and throughout South-East Asia, with the possible exception of focal areas of eastern Cambodia and northern Vietnam (WHO, 1997). In Africa, resistance rates to SP are variable ranging from 10-50% in East Africa and <10% in Central and Southern Africa (WHO, 2005a; 2005b).

Mefloquine resistance. Re-occurrence of parasitaemia* in over 50% of the patients treated with Mefloquine has been reported from border areas of Cambodia, Myanmar and Thailand. Mefloquine resistance is uncommon in other areas of South-East Asia, but has been reported in Brazil. Parasite isolates with reduced sensitivity to Mefloquine *in vitro** have been reported from Central and West Africa, although the drug has not been used operationally in these areas. This indicates that there is potential for the resistance to spread if Mefloquine monotherapy is used on a wide scale in Africa (WHO, 2001a). Sporadic cases of prophylactic* failure, in travellers, and therapeutic failure have been reported in Africa. Several studies have shown a decrease in sensitivity *in vitro*, and studies (CDC, 2007) in West Africa showed the existence of strains with decreased sensitivity to Mefloquine even before its introduction into the region for therapeutic use.

Artemisinin resistance. Re-occurrence of parasitaemia is common when these drugs are used in monotherapy. In spite of reports of decreasing *in vitro* sensitivity, there is no confirmed evidence of *in vivo** resistance of *P. falciparum* to Artemisinin and its derivatives (WHO, 2005a; WHO, 2005b).

Appendix 7: Governmental action

Vector Control. Control of malaria vectors remains one of the main strategies against malaria. The key interventions under this strategy will be promotion of ITNs and IRS (MCSP, 2001). ITNs are considered to be the most cost-effective method of malaria prevention in highly endemic areas. All vulnerable groups (e.g. children under five, pregnant women, internally displaced persons, etc.) will be encouraged to acquire the use of ITNs. The promotion of ITN use will be implemented through a public-private approach; major implementer shall include NGOs, the commercial and public sectors. The main focus of this strategy will be:

- Creation of demand for nets and insecticides
- Ensuring availability of affordable quality nets and insecticides in urban and rural retail outlets
- Provision of subsidized ITNs to vulnerable groups
- Promoting correct use of ITNs and maintenance of their effectiveness

The public sector will coordinate, set standards and develop and distribute guidelines for ITN promotion. It will also develop a system of targeted subsides and net re-treatment centres at community level, which the districts will manage. The private sector will be the main source of ITNs and insecticides. They will use commercial and social marketing approaches to create demand in both rural and urban areas. NGOs, CBOs and other civic organisations will be the main outlets of ITNs and insecticides in under-served areas.

In order to reach the poor and vulnerable a voucher system will be adopted. They will be accessed through the public system and will enable people to purchase nets and insecticides at a subsidised price from any outlet. The supplier will be reimbursed the equivalent of the subsidy. Other means of reaching the vulnerable poor with ITNs such as resolving funds will be explored.

IRS using acceptable insecticides will be instituted at a recommended frequency to halt transmission in epidemic prone areas. IRS will also be encouraged where use of ITNs is difficult (e.g. boarding schools, barracks, prison cells, and in-patients health facilities) regardless of level of endemicity. Other vector control approaches will be encouraged where appropriate.

Intermittent Preventive Treatment during pregnancy. All pregnant women will receive two doses of SP as IPT of malaria; one in the second trimester and one in

the third trimester as part of the antenatal care package. This strategy will be integrated into maternal services at both health facility and community levels and creating demand for the services. This will include training of health workers, provision of implementation guidelines, drugs and supplies. The appropriateness of SP for IPT will be closely monitored and modified as need may arise.

Home based Management (HBM) of malaria. This intervention strategy aims at:

- Improving treatment-seeking behaviour so that patients, caretakers and community leaders recognise the signs and symptoms and know what action to take and where treatment is available
- Improving access to effective diagnosis and treatment; in terms of access to physical facilities, drugs and trained providers
- Ensuring an adequate supply of effective drugs and ancillary supplies
- Strengthening facility based services and referral systems to ensure that malaria issues are addressed

First line drugs will be made available in the community through trained providers, community resource persons, supplied and supervised from nearby health unit facilities. Drug shop owners will also be trained on first line treatment and how to give appropriate advice on supportive treatment and referral.

An effective system for delivery of drugs and other supplies is essential to this strategy and the Malaria Control Strategic Plan (MCSP) and other malaria partners within the Ministry of Health will collaborate with the National Medical Stores and private suppliers. First line anti-malarials will be packed in unit courses to ensure dose compliance and distributed through front-line health outlets to ensure early treatment of malaria patients.

Epidemic prevention preparedness and response. The MCP will institute activities to check epidemics principally in three distinct phases, namely before, during and after the epidemic. Before an epidemic low-grade activity, like community mobilization, health education and monitoring of malaria cases at health facilities will be undertaken. Other activities in this phase will include preparations for epidemic diagnosis and control. General district preparedness plans will be set up, with the help of MCP, so as to enable districts to:

- Develop and implement district level malaria epidemic plans
- Establish and use an early warning system
- Map epidemic prone villages and monitor malaria cases in the villages

- Ensure adequate buffer stocks of drugs, insecticides and other essential supplies

During epidemics the MCP will ensure prompt mobilization and distribution of resources, swift sharing of information, and easy mobility of patients to treatment centres. It will work with districts to establish temporary treatment centres in the hard-hit areas. After the epidemic, the MCP will review its experience with the contained epidemic so as to document experiences and use them in the future. It will develop a tool for post-event evaluation of epidemics and their control to guide the assessment.

Implementation overview 2003. Since 2000, major steps have been taken in Uganda towards attaining the Abuja targets.

Policy, strategy and systems:

- Political commitment at various levels has been demonstrated
- Increased awareness by Ministry of Health, districts and external partners of the burden of malaria
- Central level strengthening of the MCP in terms of number of personnel
- Significant progress in malaria policy and strategy development

Effective treatment and IPT

- Successful implementation of the new antimalarial drug policy
- Design and implementation of HBMF strategy
- Supply of antimalerials has improved with overall systems strengthening
- Nationwide implementation of IPT

ITNs

- Acceptance of ITNs as an effective intervention among policy-makers
- Removal of taxes and tariffs on ITNs
- Development of robust public sector/private sector/civil society partnership for scaling up ITNs through the ITN Working Group (WG)
- Design and piloting of national ITN voucher scheme

Significant progress has been made in the development of policies, strategies and partnerships. In order for the current momentum to not be lost, it is necessary that the identified interventions are now implemented at national scale.

ITN coverage among under-fives. One of the MCSP targets is to increase the proportion ofunder-foves, regularly sleeping under ITNs, from 5% to 50%. It is estimated that by the end of 2005, 45% of under-fives will be sleeping under an ITN if the following occurs:

- The commercial ITN market continues to expand and prices fall
- NetMark begins to support private sector distributors and carries out promotion of ITNs in 2003 and in 2004 NetMark activities are in full swing
- The National Voucher Scheme is piloted in 4 districts in 2003; it will be implemented in 2004, and continues and extends to new districts in 2005
- The national ITN free re-treatment system is implemented early in 2004, after preparatory work in 2003, and enables the majority of conventional nets to be treated and increases ITN coverage
- Free distribution of ITNs to pregnant women and under-fives in refugee camps in Northern Uganda
- Community-based NGO activities continue

IPT coverage among pregnant women. Another target of the MCSP is to increase the proportion of pregnant women receiving protection against malaria through IPT to 60%. It is estimated that by the end of 2005, 30% of pregnant women will be receiving these 2 doses if the following occurs:

- HBMF is scaled up and includes counselling on IPT to child carers. This is coupled with other activities that aim to increase the timing and frequency of antenatal care visits by pregnant women
- Improvement of reproductive health services by strengthening the health system. The USAID UPHOLD Programme provides additional support in this area

However, due to pregnant women attending antenatal* care late in pregnancy or only attending once, prevents IPT coverage from increasing at a faster pace.

Access to effective treatment. A third MCSP target is to increase the proportion of the population who receive effective treatment for malaria within 24 hours of the onset of symptoms, from 30% to 60%. It is estimated that by the end of 2005, 60% of under-fives will be receiving this treatment if the following occurs:

- Antimalarial supply to health facilities improves due to donor-procured drugs and the change in the drug supply system.
- Homapak implementation, with commercial versions launched by pharmaceutical manufacturers widely available in urban and rural retailers, improving access to effective treatment at the community level.

If the MCSP and its partners are able to access global funds effectively and efficiently by early 2004 and fully utilise the opportunities within the health system, then by the end of 2005 it is envisaged that Uganda will not fall far short of obtaining the targets.